

**REMEDIAL INVESTIGATION/FEASIBILITY STUDY
ADDENDA
FOR THE TEST AREA NORTH GROUNDWATER OPERABLE UNIT
AT THE IDAHO NATIONAL ENGINEERING LABORATORY**

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May 1992

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Prepared for the
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
Under DOE Idaho Field Office
Contract DE-AC07-76ID01570

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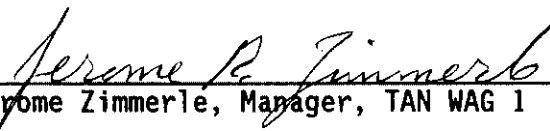
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ACRONYMS

ARDC	Administrative Records and Document Control
ASTM	American Society for Testing Materials
bls	below land surface
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain of custody
COCA	Consent Order and Compliance Agreement
CRQL	contract-required quantitation limits
DMP	Data Management Plan
DOE	Department of Energy
DOT	Department of Transportation
DQOs	data quality objectives
EA	evaluation of alternatives
ED	engineering design
EPA	Environmental Protection Agency
ERD	Environmental Restoration Department
FFA/CO	Federal Facility Agreement/Consent Order
FR	Federal Register
FSM	field sampling method
FSP	Field Sampling Plan
HNu	photoionization detector
HRS	Hazard Ranking System
INEL	Idaho National Engineering Laboratory
LOFT	Loss-of-Fluid Test Facility
MCL	maximum contaminant level

MOSA	Methods of Soil Analysis
NCP	National Contingency Plan
NPL	National Priorities List
PCE	tetrachloroethylene
ppb	parts per billion
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QC	quality control
RA	risk assessment
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI/FS	remedial investigation/feasibility study
RML	Radiation Measurements Laboratory
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SC	site characterization
SOP	standard operating procedure
SOW	statement of work
SWMUs	solid waste management units
TAN	Test Area North
TCE	trichloroethylene
TCL	target compound list
TCLP	toxic characterization leaching procedure
TSF	Technical Support Facility
USGS	United States Geological Survey
VOA	volatile organic analysis
VOC	volatile organic compound
WRRTF	Water Reactor Research Test Facility

1. INTRODUCTION AND BACKGROUND

1.1 SAMPLING AND ANALYSIS PLAN

The purpose of this Sampling and Analysis Plan is to guide the collection and analysis of samples for a remedial investigation of the TAN Groundwater Operable Unit. This investigation has been chosen to facilitate data development at this operable unit pursuant to a Federal Facility Agreement/Consent Order (FFA/CO) among the DOE, the EPA, and the State of Idaho, which will guide the overall CERCLA response at the INEL.

The Sampling and Analysis Plan consists of three parts: the Field Sampling Plan (FSP), the Quality Assurance Project Plan (QAPjP), and the Data Management Plan (DMP). These plans have been prepared pursuant to the NCP (EPA, 1990) and guidance from EPA on the preparation of sampling and analysis plans. The FSP describes the field activities that will occur as part of the remedial investigation, the QAPjP describes the processes and programs that will be used to ensure the data generated will be suitable for its intended use, and the DMP describes the flow of data from generation to use.

1.2 INEL BACKGROUND

The Idaho National Engineering Laboratory (INEL) is located 42 mi west of Idaho Falls, Idaho, and occupies 890 mi² of the northwestern portion of the Eastern Snake River Plain (Figure 1-1). The INEL is bounded on the northwest by three mountain ranges: Lost River, Lemhi, and Bitterroot. The remainder of the INEL is bounded by the Eastern Snake River Plain (Bowman et al., 1984).

The INEL was established in 1949 by the U.S. Atomic Energy Commission to build, operate, and test various nuclear reactors and fuel processing plants, and to provide support facilities. To date, 52 reactors have been constructed, 13 of which are still operable. Today, the INEL also supports other government-sponsored projects including energy, defense, environmental, and ecological research.

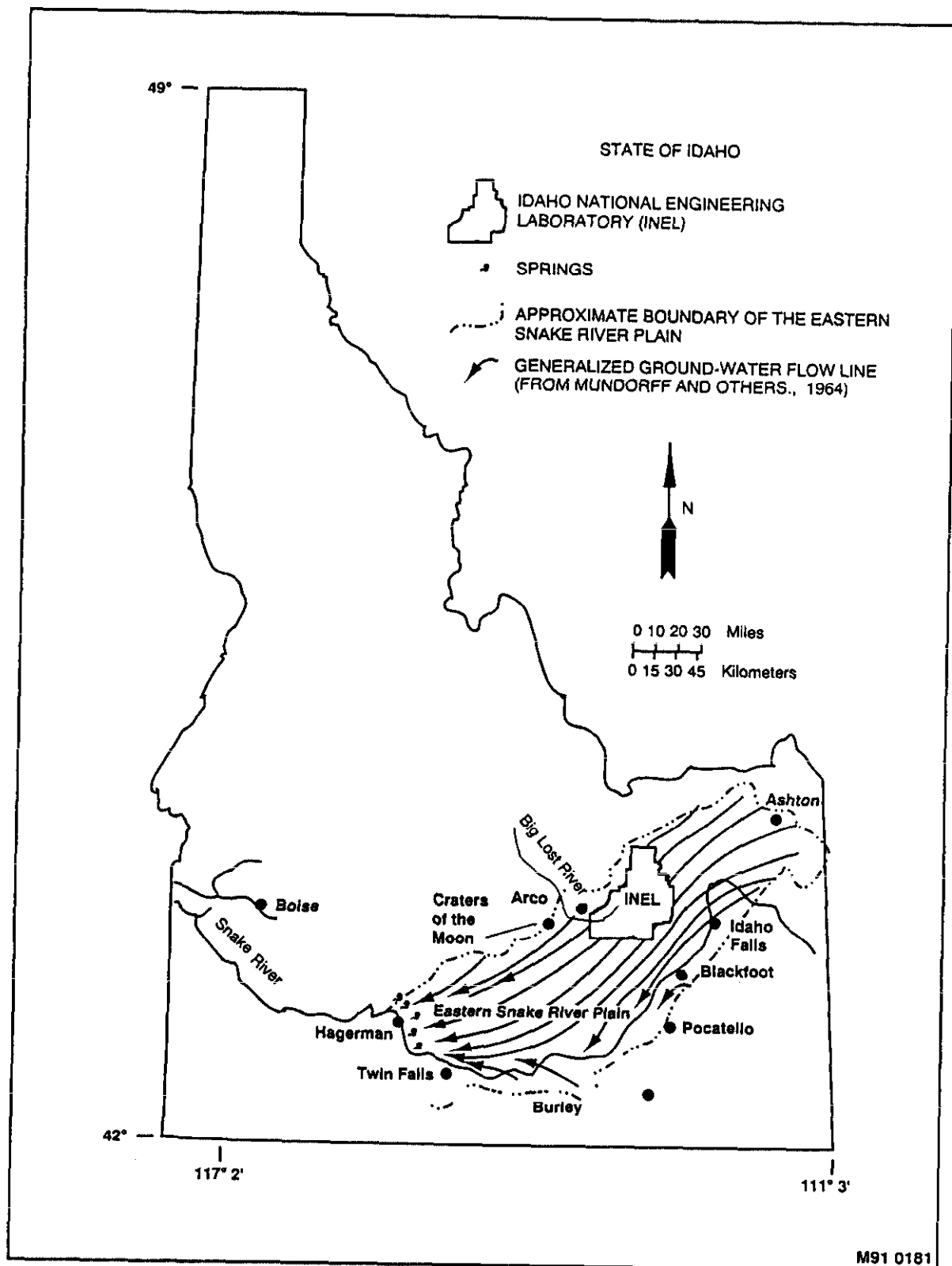


Figure 1-1. Map of Idaho showing the location of the INEL, Snake River Plain, and generalized groundwater flow lines of the Snake River Plain Aquifer.

1.3 TAN OPERABLE UNIT REGULATORY HISTORY

The Environmental Protection Agency (EPA) proposed listing the INEL on the National Priorities List (NPL) of the National Contingency Plan (NCP) July 14, 1989 (54 FR 29820). This was done using Hazard Ranking System (HRS) procedures found in the NCP. After considering public input during a 60-day comment period following the proposed INEL listing, EPA issued a final rule listing the INEL Site. The rule was published in the Federal Register, November 21, 1989.

The TAN injection well and associated groundwater system was one of three release sites in the Consent Order and Compliance Agreement (COCA) (EPA, 1987a) identified for remedial action under RCRA. The groundwater was being addressed through RCRA regulations as a release site, and a Corrective Action Plan was prepared under COCA provisions. Subsequent to listing the INEL on the NPL and with the development of the FFA/CO, the DOE, the EPA, and the State of Idaho have decided that the TAN groundwater system should be remediated through the CERCLA-driven RI/FS process. The FFA/CO establishes the procedural framework and schedule for developing, prioritizing, implementing, and monitoring response actions at the Site in accordance with CERCLA, RCRA, and the Idaho Hazardous Waste Management Act.

1.4 TAN BACKGROUND

1.4.1 Geology

TAN is located in the northern portion of the INEL (Figure 1-2). The geology of TAN is characterized by basalt flows with sedimentary interbeds overlain by lacustrine sediments from the ancestral Terreton Lake, and playa deposits from both the Birch Creek and the Big Lost River. The lacustrine deposits are exposed at the surface in the southeastern portion of TAN. To the northwest, the deposits are overlain by 2 to more than 10 ft of Birch Creek playa deposits. The underlying basalt is a very dark, hard, tholeiitic basalt that has shown distinct hexagonal jointing in excavations (Nace et al., 1956). Geologic descriptions from wells drilled in the TAN area indicate that

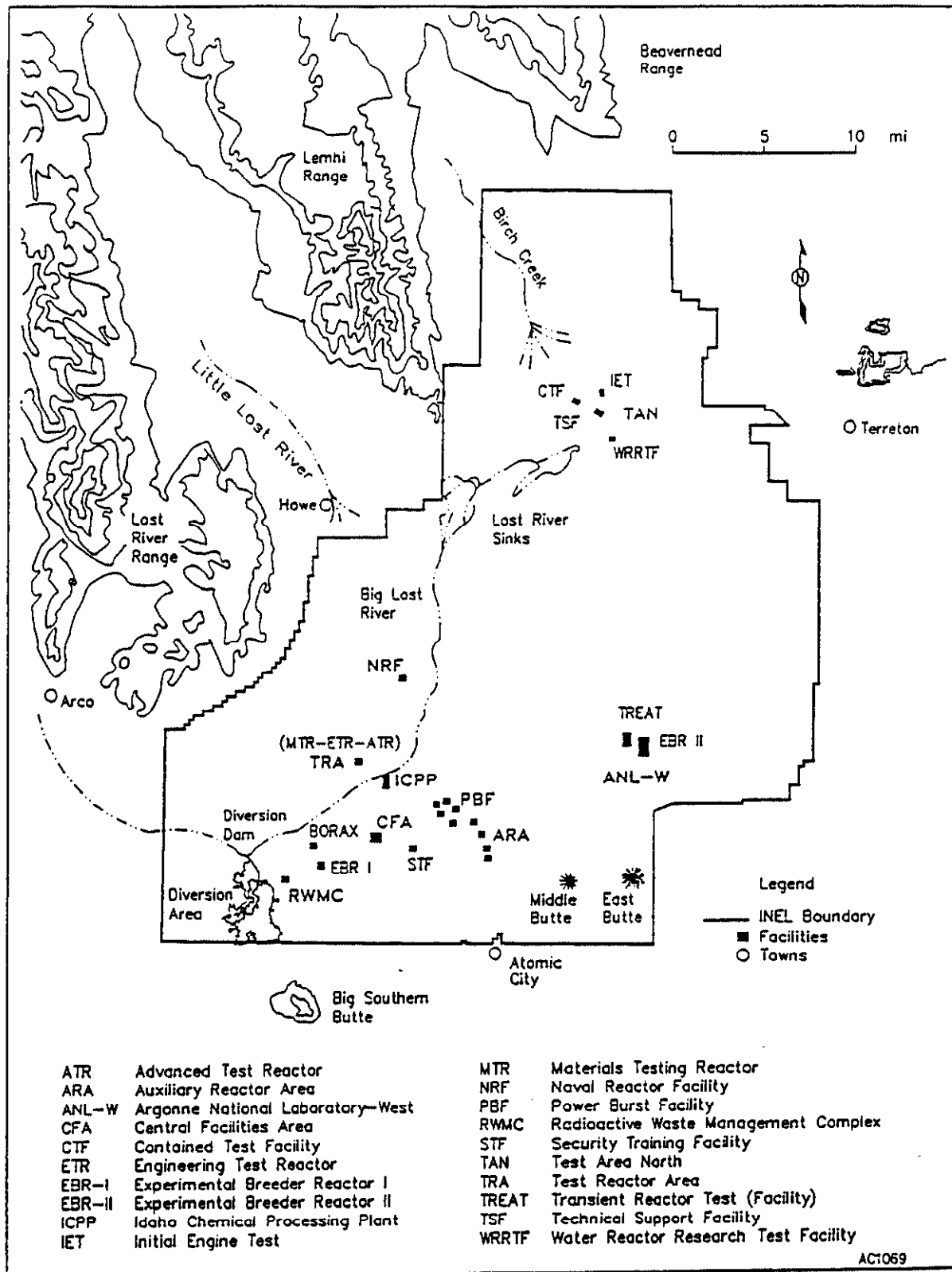


Figure 1-2. Location of the facilities within the INEL.

the basalt exhibits a wide range of lithologic textures and structures, from dense to highly vesicular basalt, and from massive to highly fractured basalt. Individual flow units have a median thickness of about 15 ft. The underlying interbeds at TAN, with a median thickness of about 4 ft, are much thinner than interbeds found elsewhere on the INEL, with a median thickness of about 10 ft.

In general, TAN soils have formed as a result of alluvial or aeolian deposition over basalt lava flows and are derived from silicic volcanic and paleozoic rocks from the nearby mountains and buttes (Nace et al., 1956). Surface soils at TAN are primarily silt loams and silty clay loams, derived from sediments in the ancient Lake Terretton (Martin et al., 1990). Wells drilled at TAN indicate that the thickness of the alluvium varies from 5 to 75 ft thick, with a decreasing thickness in alluvium to the east. The wide variation in the alluvial thickness is due largely to the irregular nature of the underlying basalt flows.

Highly porous and fractured basalt rock underlies the relatively shallow soil at TAN. Numerous wells have been drilled in the TAN vicinity for various reasons, typically for water supply, injection, or monitoring (Figure 1-3).

Several lithologic types were encountered in interbeds within the basalt. Sedimentary interbeds of clay and silt material, which often contain clasts of basalt, and interbeds consisting of basaltic breccia supported by a matrix of scoriaceous rubble are most common. The least common interbed is composed entirely of sandy material. Figure 1-4 shows the location of geologic cross-section lines (west-east and north-south) at TAN. Figures 1-5 and 1-6 present west-east and north-south cross-sections through TAN, respectively. The two most prominent interbeds at TAN are the P-Q and Q-R interbeds. The P-Q interbed has only been found in approximately 40% of the wells drilled deep enough to penetrate it and thus appears to be laterally discontinuous. To date, only three boreholes have been drilled deep enough to penetrate the Q-R interbed but in all three cases the presence of the Q-R was noted. An evaluation of geologic and hydrologic data suggest that the Q-R interbed may be laterally continuous and thus confining (see discussion Sections 2.1.5 and 2.1.6.6 of the Work Plan). In general, the interbeds can be correlated between wells and represent subsurface features which may influence contaminant migration in the groundwater system. The dashed lines in

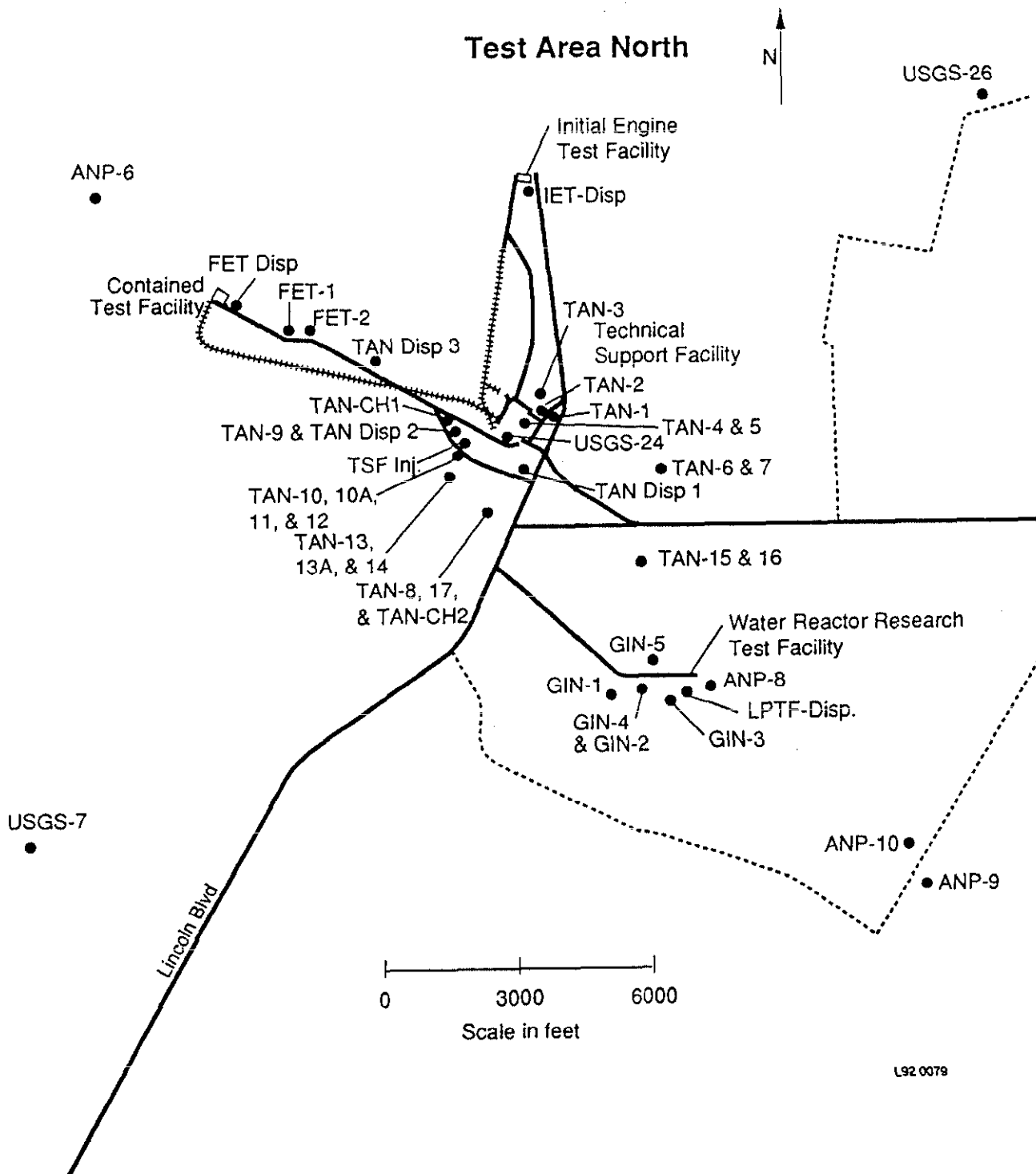


Figure 1-3. Locations of wells in the vicinity of TAN.

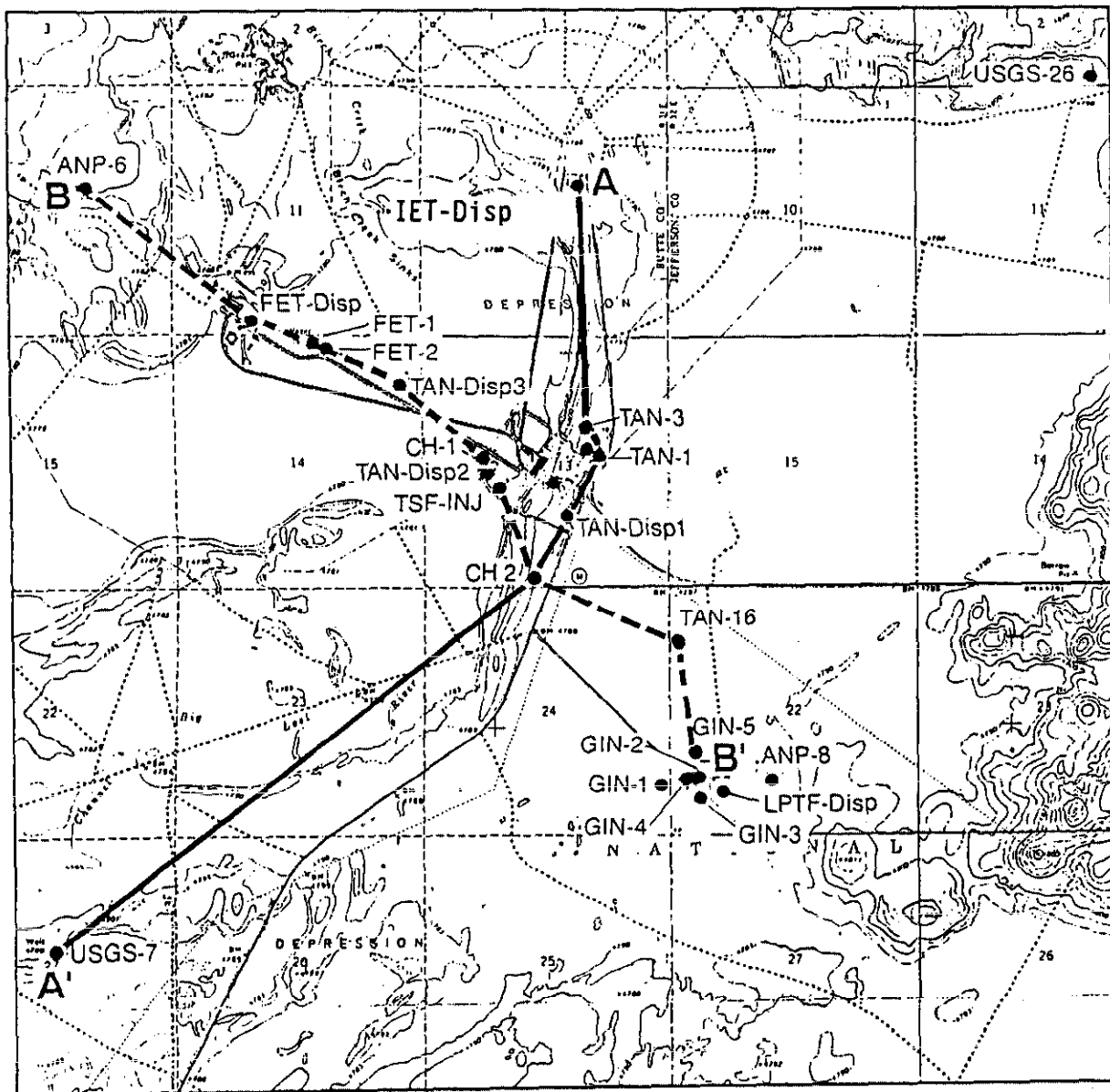


Figure 1-4. Locations of geologic cross-section lines, west-east and north-south at TAN.

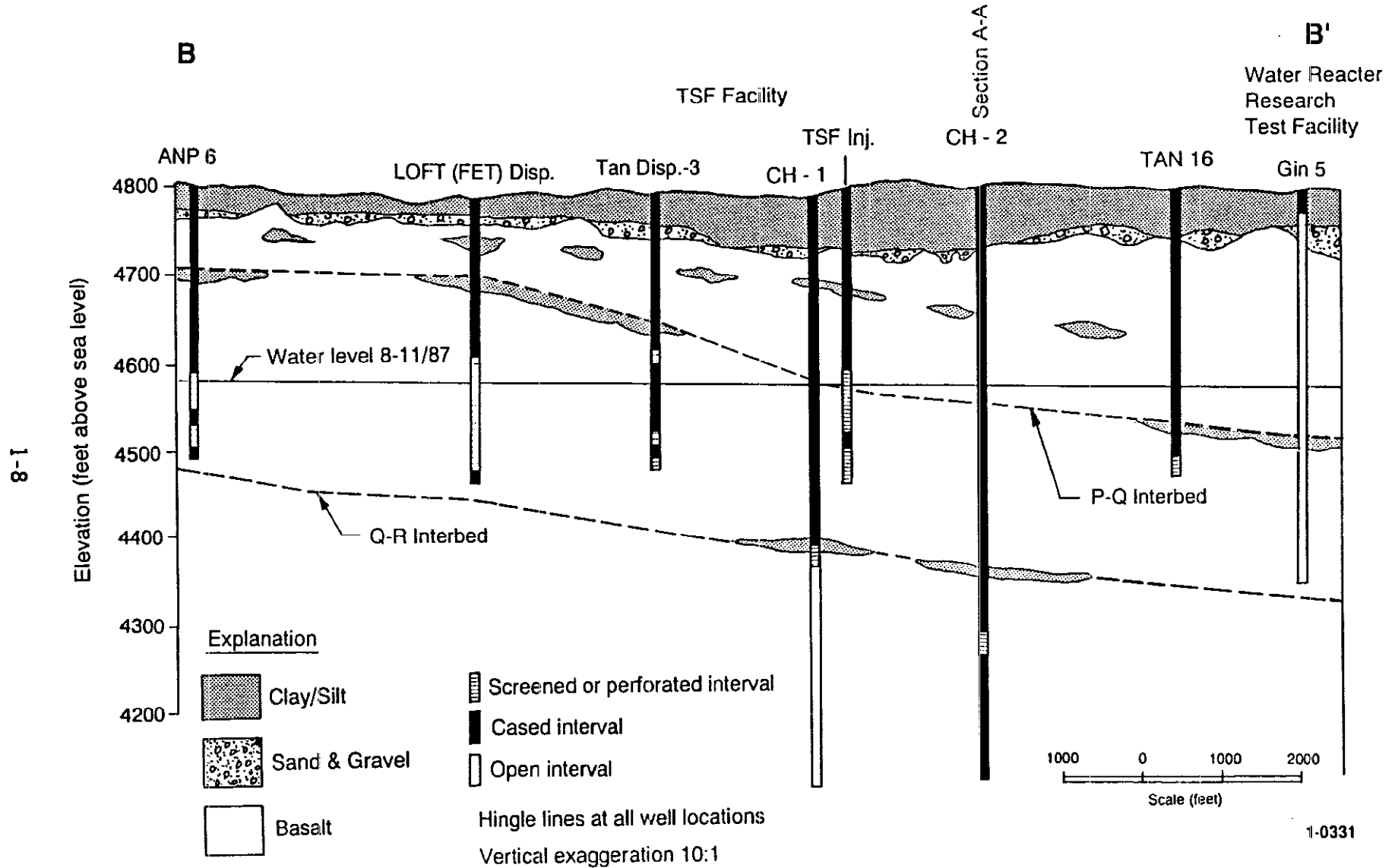


Figure 1-5. West-east geologic cross-section through TAN.

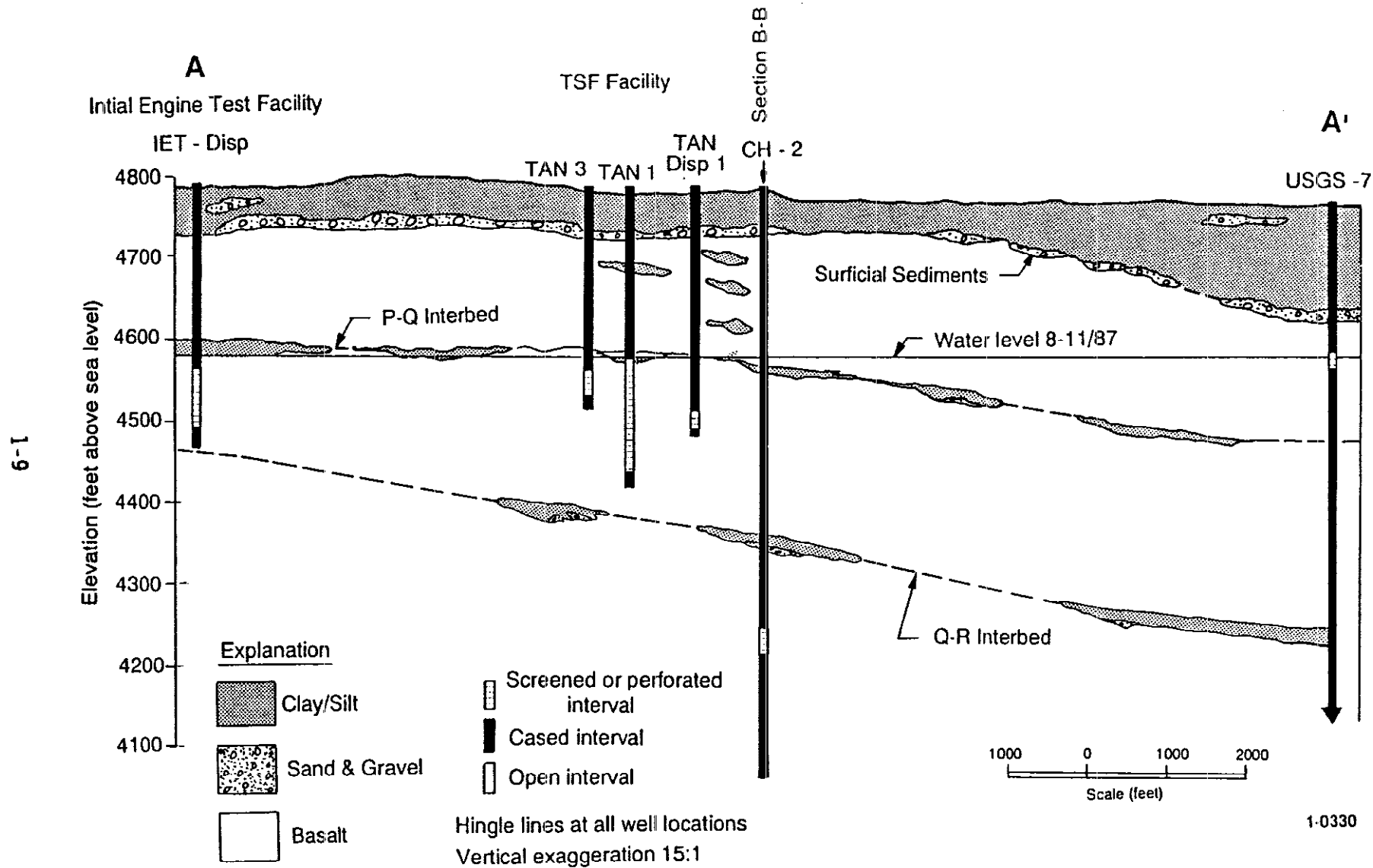


Figure 1-6. North-south geologic cross-section through TAN.

Figures 1-5 and 1-6 represent the expected stratigraphic position of the P-Q and Q-R interbeds (if present).

1.4.2 Waste Areas/Waste Characteristics

A detailed description of the waste areas and waste characteristics potentially affecting groundwater quality at TAN is provided in Section 2.3 of the RI/FS Work Plan.

1.5 TYPES AND VOLUMES OF WASTES DISPOSED TO THE TSF-05 INJECTION WELL

The Technical Support Facility (TSF) injection well (TAN-330/TSF-05) was drilled in 1953 to a depth of 305 ft to dispose of liquid effluents and sludges generated at TSF. It is located just south of TAN-655 (see Figure 2-23 of the Work Plan). The well has a 12-in.-diameter casing to 305 ft. The depth to groundwater is about 206 ft bls. The well was last used as a primary disposal site in September 1972, after which waste waters were diverted to the TSF disposal pond. Until the early 1980s, the well was used for overflow from the sump at TAN-655 in the event power failure, equipment failure, or equipment maintenance precluded discharge to the pond.

Discharges to the TSF injection well included treated sanitary sewage, process waste waters, concentrated evaporator sludges and low-level radioactive waste streams. The hazardous wastes included corrosive and ignitable wastes from shop operations and potentially corrosive and TCLP toxic condensate from the intermediate-level waste disposal system evaporator. The TCLP toxic heavy metals are suspected because of mercury contamination in the late 1950s and early 1960s, the use of a potassium chromate solution in decontamination activities after 1970, and the lead used for shielding materials that were decontaminated with corrosive solutions. The amounts of these metals in the evaporator condensate that may have reached the well are unknown. Personnel interviews indicate that concentrated material from the evaporator system was discharged to the injection well from the late 1950's to the early 1960's. The TSF injection well also received low-level radioactive wastes. The Radioactive Waste Management Information System contains curies

by nuclide released to the TSF injection well for 1971 through August 1972. Records of the radioactivity released before 1971 are questionable, but published estimates put the amount released from 1959 through 1970 at about 45 Ci. However, no distribution by nuclides is available. Table 2-9 of the RI/FS Work Plan shows the nuclide distribution for 1971 and 1972 releases and the calculated distribution for 1959 to 1970 releases assuming the same distribution. Estimated total releases for 1959 through August 1972 are also provided in Table 2-9 of the Work Plan.

As discussed in Section 2.3.2 of the Work Plan, historical records provide little definitive information on the types and volumes of organic wastes disposed to the injection well. However, based on existing characterization data of groundwater and sludge from the well (see Section 1.6 FSP, Section 2.3 and Appendix B of Work Plan), disposal of fairly large quantities of volatile organics and radionuclides are indicated. A preliminary estimate suggests that as much as 35,000 gal of TCE may have been disposed to the well; however, this number was based on personnel interviews and may be an over estimate. Estimates based on groundwater concentrations and the known extent of contamination suggest that several thousand gallons may be a lower limit, but it should be noted that this calculation did not account for the potential presence of DNAPL.

1.6 EXISTING CHARACTERIZATION DATA

During routine water sampling by EG&G Idaho in April 1987, a sample collected from the TSF production well TAN-1 (also referred to as TAN-612) indicated possible trichloroethylene (TCE) contamination of the groundwater. Wells TAN-1 and TAN-2 (TAN-613) were resampled in both September and November, 1987. Resampling efforts confirmed the presence of TCE in TAN-1 at concentrations between 4.4 and 8 ppb and TCE concentrations of 2 to 3 ppb in TAN-2. The detection of organic contaminants at the wellhead from these two TSF production wells represented a confirmed release to a critical receptor, since these wells supply the water for personnel at TSF.

As a result of this confirmed release, a RCRA Corrective Action Program was developed to address groundwater contamination at TAN. One of the first

actions initiated was the 1989 installation of an air sparging system to the water supply system to reduce TCE concentrations below safe drinking water levels. A RCRA Facility Investigation (RFI) Work Plan was also generated (EG&G Idaho, 1988), and RFI activities were conducted in FY-89 and FY-90. In FY-91, the TAN RFI was replaced by a RI/FS due to the INEL change from COCA to the FFA/CO. The following sections discuss the possible sources of contamination (as identified in Section 2.3 of the Work Plan) and existing characterization data. Both pre-RFI and RFI activities were carried out to characterize possible contaminant sources and to ascertain the extent of understanding with respect to the groundwater contamination problem at TAN.

1.6.1 Possible Sources

Based on past disposal practices, historical records, and personnel interviews, and on waste stream/generation information (Section 2.3 of the Work Plan), three solid waste management units (SWMUs) at TSF could have received TCE, tetrachloroethylene (PCE) or other organic chemicals and were therefore targeted for further investigation as part of the RFI activities. These three SWMUs are units TSF-07 (TSF disposal pond), TSF-05 (TSF injection well), and TSF-11 (TSF clarifier pits). Subsequent to the RFI, both the IET injection well (IET-06) and the WRRTF injection well (WRRTF-05) have been identified as possible sources of groundwater contamination, in part because each provides a direct route for contaminants to the aquifer.

1.6.2 Characterization of Possible Sources

Table 1-1 represents a summary of sampling activities carried out prior to final issuance of the TAN Groundwater RFI Work Plan (EG&G Idaho, 1988) as well as the sampling conducted since that time. The following discussions focus on characterization data for volatile organics, specifically TCE, since TCE represents the contaminant of greatest concern and is also the most widely distributed contaminant.

1.6.2.1 Surface Sources. Analytical results from sediment samples from potential surface sources (TSF-07 and TSF-11) suggest that these sites are not

Table 1-1. Pre-RFI and RFI characterization tasks

Task	Date	Comments
<u>Pre-RFI</u>		
• TSF clarifier pit sludge sampling	December 1987	Samples analyzed for volatile and semivolatile organics, pesticide organics, and inorganics (see EG&G Idaho, 1988 and Appendix K of the Work Plan)
• TSF injection well	--	See RFI tasks
• TSF disposal pond	--	See RFI tasks
• Soil gas survey	May 1988	Results inconclusive with respect to identifying a groundwater contaminant plume
<u>RFI</u>		
• Groundwater samples collected from wells in the vicinity of the TSF-05 injection well	March 1989	Validated analytical results indicated elevated TCE concentrations in the groundwater (see Appendix G of the Work Plan)
• Augering and split spoon sampling of surficial sediments in areas with elevated TCE soil gas readings	July-Nov 1989	Depth profile sampling for Appendix IX constituents, volatile organic compounds (VOCs), metals, and radionuclides from the TSF disposal pond (5 boreholes, 3 perched water piezo-meters), and at 2 areas inside TSF (see Appendix A of the Work Plan)
• Groundwater sampling of 19 monitoring and observation wells	Oct 1989-Jan 1990	Samples analyzed for VOCs, metals, alkalinity, anions, and radionuclides (see Appendix C of the Work Plan)
• Removal of 55 ft of sediment/sludge from the TSF injection well	Jan-Feb 1990	Analysis of sediment/sludge for VOCs, metals, and radionuclides (see Appendix B of the Work Plan)

Table 1-1. (continued)

Task	Date	Comments
<ul style="list-style-type: none"> Groundwater sampling of 29 monitoring and observation wells 	Oct-Dec 1990	Samples analyzed for VOCs, metals alkalinity, anions, and radionuclides (see Appendix D of the Work Plan)

contributing volatile organic contaminants to the groundwater system at TAN. Extensive depth profile sampling in the TSF disposal pond (TSF-07) was conducted because this site was the terminal disposal site for several waste streams or processes that used TCE. Tabulated validated analytical results from this sampling effort are provided in Appendix A of the Work Plan. Although organic contaminants were not detected at elevated levels in either the sediments or perched water beneath the pond, the presence of metals and radionuclides was noted. Further investigation of the TSF disposal pond will not be carried out under the TAN Groundwater RI/FS due to the fact that available data indicate that organic constituents are not a concern in the pond.

Preliminary results from the analysis of sediment samples from the TSF-11 clarifier pits also suggest that this site is not a source of TCE to the groundwater system. The analytical results for the samples collected at this site can be found in EG&G Idaho (1988) and in Appendix K of the Work Plan.

1.6.2.2 TSF-05 Injection Well. Based on the results of groundwater quality analyses from the injection well, as well as from analytical and radiological analysis of sediment/sludge removed from the well in 1990, the TSF-05 injection well is the primary source of groundwater contaminants at TAN. Elevated concentrations of TCE and PCE have been detected as a result of several sampling efforts by the USGS and EG&G Idaho since 1988. Groundwater quality data from these past sampling events show TCE concentrations at the well head ranging from 16 to 30 mg/L. Tetrachloroethylene (PCE) was also detected at concentrations above drinking water standards.

During January and February 1990, 55 linear ft (from well depths between 250 and 305 ft) of sediment/sludge was removed from inside the well casing. Analysis of this material indicated very high (~2%) TCE concentrations in the sludge, as well as elevated concentrations of radiological and metal constituents (tritium and cesium). Table 1-2 presents a summary of contaminant concentrations in the sludge (also see Appendix B of the Work Plan). The temporal effects of this initial sludge removal effort can not be fully evaluated with existing data. As can be seen in the following figures, both increases and decreases in TCE concentrations were found in the groundwater monitoring wells between FY-89 and FY-90.

1.6.2.3. IET and WRRTF Injection Wells. Groundwater samples from the IET injection well have been collected annually since 1987. In 1987, TCE was detected in this well at 1.3 $\mu\text{g/L}$. Since that time, TCE has not been detected. Although available data indicate that the IET injection well is not a source of contaminants to the groundwater system, groundwater samples will be collected and analyzed as part of the RI/FS because this well was a disposal site for the IET Facility and also because TCE was detected in 1987.

The WRRTF injection well has been grouted up and abandoned, and is therefore inaccessible for characterization. However, a number of aquifer wells are located in the vicinity of the WRRTF injection well and have been periodically sampled. TCE has been detected in three of these wells (GIN-2 and GIN-4 in 1990, and ANP-8 in 1989 and 1990). Of the three, only ANP-8 has shown TCE above the MCL of 5 $\mu\text{g/L}$. Although existing data indicate that the TSF-05 injection well is probably the source of TCE in the groundwater at WRRTF, the WRRTF injection well cannot be ruled out as a potential source. Therefore, additional characterization/monitoring of the wells in the WRRTF area is planned under the RI/FS.

1.6.2.4 Regional Aquifer. Based on existing water quality data (pre-FY-89) and the results from groundwater sampling of wells in the vicinity of the injection well (March 1989; see Appendix G of the Work Plan), eight groundwater monitoring wells were drilled and installed in late FY-89 and early FY-90. Subsequent to monitor well construction, a network of 19 new and existing monitoring, production, and observation wells within a radius of approximately 1 to 2 mi of the TSF injection well were sampled for analysis of

Table 1-2. Contaminant concentrations in TSF-05 injection well sludge

<u>Substance</u>	<u>Environmental Concentration (with units)</u>	<u>In Sample (soil, water, etc.)</u>
Methylene chloride	290 ppm	In sludge
1,2-dichloroethene	410 ppm	In sludge
Trichloroethylene	30,000 ppm 35 ppm	In sludge In water
Tetrachloroethylene	2,800 ppm	In sludge
2-butanone (MEK)	1,800 ppm	In sludge
Cobalt-60	812 picocuries/gm	In sludge
Cesium-137	2,540 picocuries/gm	In sludge
Europium-154	6.62 picocuries/gm	In sludge
Americium-241	23.6 picocuries/gm	In sludge
Tritium	1,000 picocuries/ml	In sludge
Plutonium-239	12.2 picocuries/gm	In sludge

VOCs, metals, radionuclides, alkalinity, and common anions (see Appendix C of the Work Plan for validated analytical results).

The distributions and concentrations of TCE, PCE, and DCE (total) in the groundwater, based on the FY-89 sampling event, are presented in Figures 1-7, 1-8, and 1-9, respectively. FY-89 groundwater quality data show that high concentrations of TCE (i.e. 660 $\mu\text{g/L}$ - 28 mg/L) are present within 1/4 mi of the injection well. However, as shown in Figure 1-7, TCE concentrations exceeding 5 $\mu\text{g/L}$ were detected as far away as the Water Reactor Research Test Facility (WRRTF), 1.5 mi down-gradient from the injection well. Furthermore, as shown on Figure 1-7, TCE concentrations generally decrease with increasing distance from the TSF-05 injection well.

In late FY-90, nine additional groundwater monitoring wells were installed, and groundwater samples from a network of 29 new and existing wells

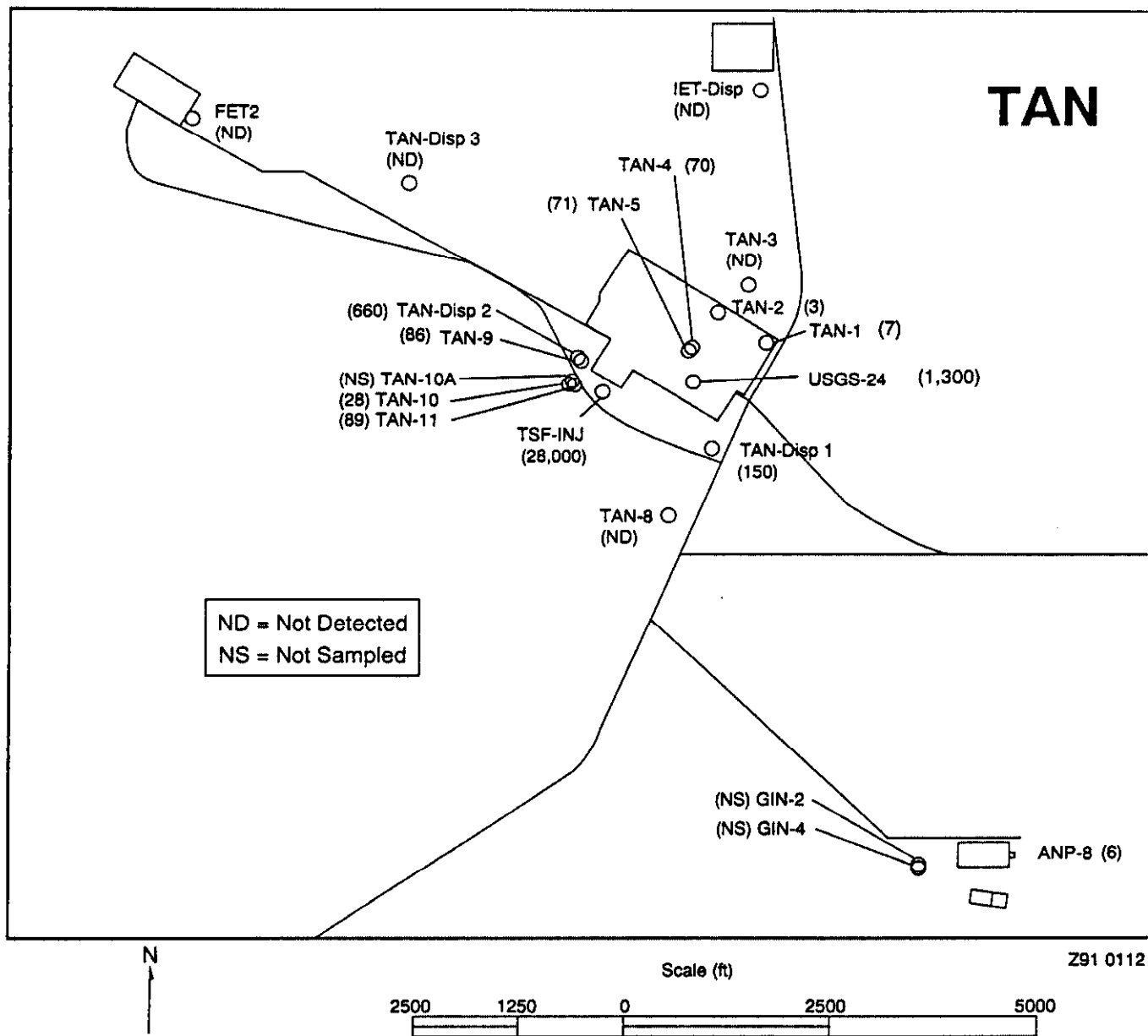


Figure 1-7. Distribution and concentration of TCE - FY-89 (concentrations shown in () are in µg/L).

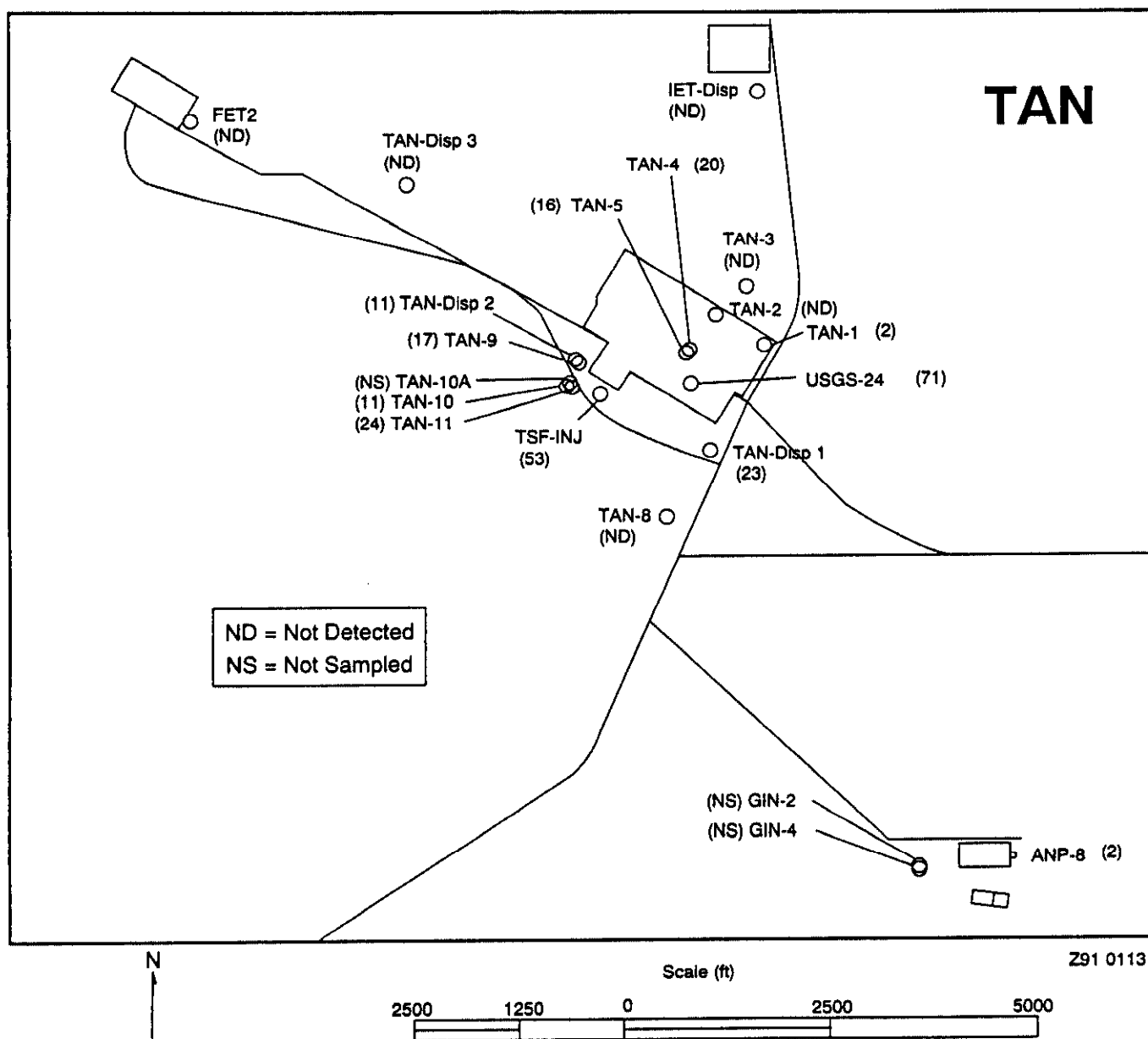


Figure 1-8. Distribution and concentration of PCE - FY-89 (concentrations shown in () are in $\mu\text{g/L}$).

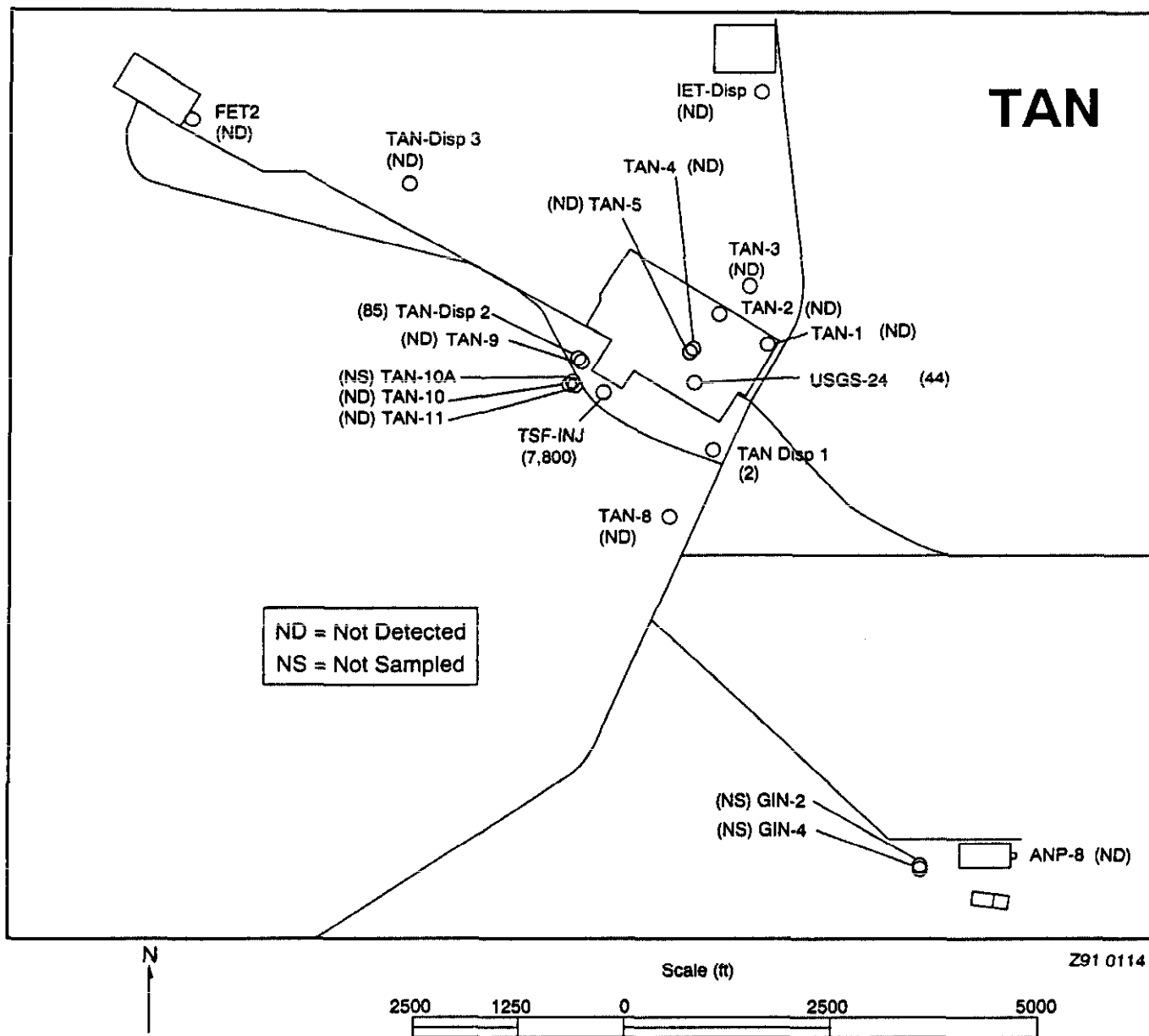


Figure 1-9. Distribution and concentration of 1,2-DCE (total) - FY-89 (concentrations shown in () are in $\mu\text{g/L}$).

were sampled in an effort to define the lateral extent of TCE contamination. Validated analytical results from this sampling effort are provided in Appendix D of the Work Plan. As shown in Figures 1-10, 1-11, and 1-12, the distributions and concentrations of TCE, PCE, and DCE (total) found in FY-90 are similar to those noted for FY-89. A graphical representation of the known lateral extent of TCE at concentrations above the action limit of 5 $\mu\text{g/L}$, based on FY-90 analytical results, is shown on Figure 1-13. It should be noted that the TSF injection well concentration shown on Figures 1-10 through 1-14 are from FY-89 analysis. As a result of FY-89 and FY-90 characterization activities, the northern, eastern and western lateral extent of TCE contamination in the groundwater is fairly well known in the shallow part of the aquifer (200-400 ft bls). However, the vertical and southern extent of contamination has not been defined. This is illustrated in Figures 1-13 and 1-14, which show the lack of definition for the southern and vertical extent of contamination, respectively.

1.6.2.5 Additional Characterization Data. In addition to sediment and groundwater analyses, a number of other tasks (i.e., drilling and installation of monitoring wells, slug tests on monitoring wells, monthly water level measurements) were completed during the RFI in FY-89 and FY-90. Construction details for all TAN area wells, including USGS wells, are included in Appendix E of the Work Plan. Also presented in Appendix E are the available lithologic and geophysical logs for both USGS wells and wells installed as part of the TAN RFI. Additionally, water level measurements from available wells in the vicinity of TAN were collected on a monthly basis from January 1990 to December 1990. Water level data sheets and potentiometric maps are provided in Appendix F of the Work Plan.

1.7 PROJECT ORGANIZATION AND RESPONSIBILITY

Several organizations will be directly involved in performing and reviewing this project. The project documentation receives internal review, which is outlined in the Environmental Restoration Department (ERD), Program Directive (PD) 2.2, Internal and Independent Review of Documents. An organizational chart for sampling and analysis activities for the groundwater is shown in Figure 1-15.

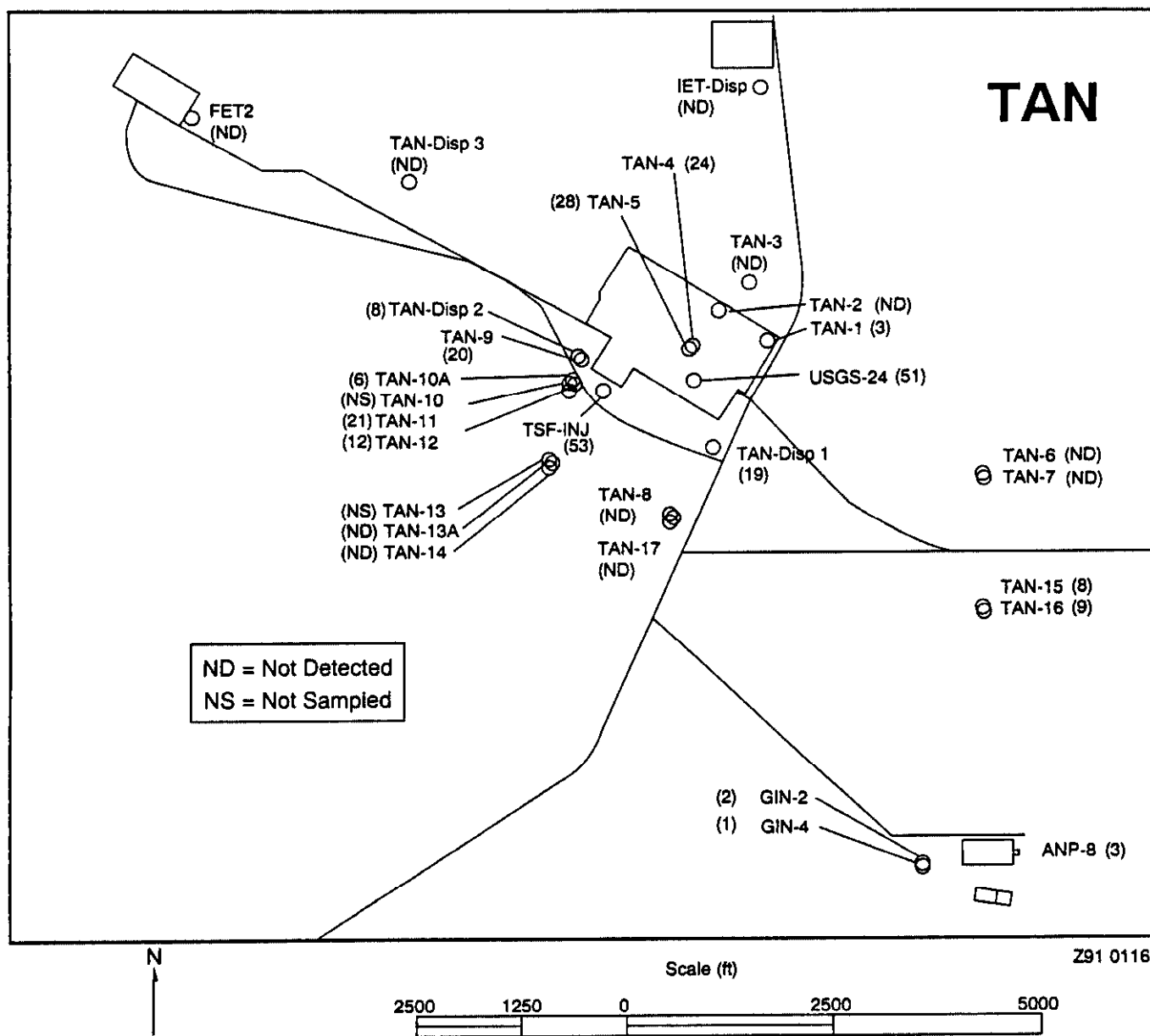


Figure 1-11. Distribution and concentration of PCE - FY-90 (concentrations shown in () are in $\mu\text{g/L}$).

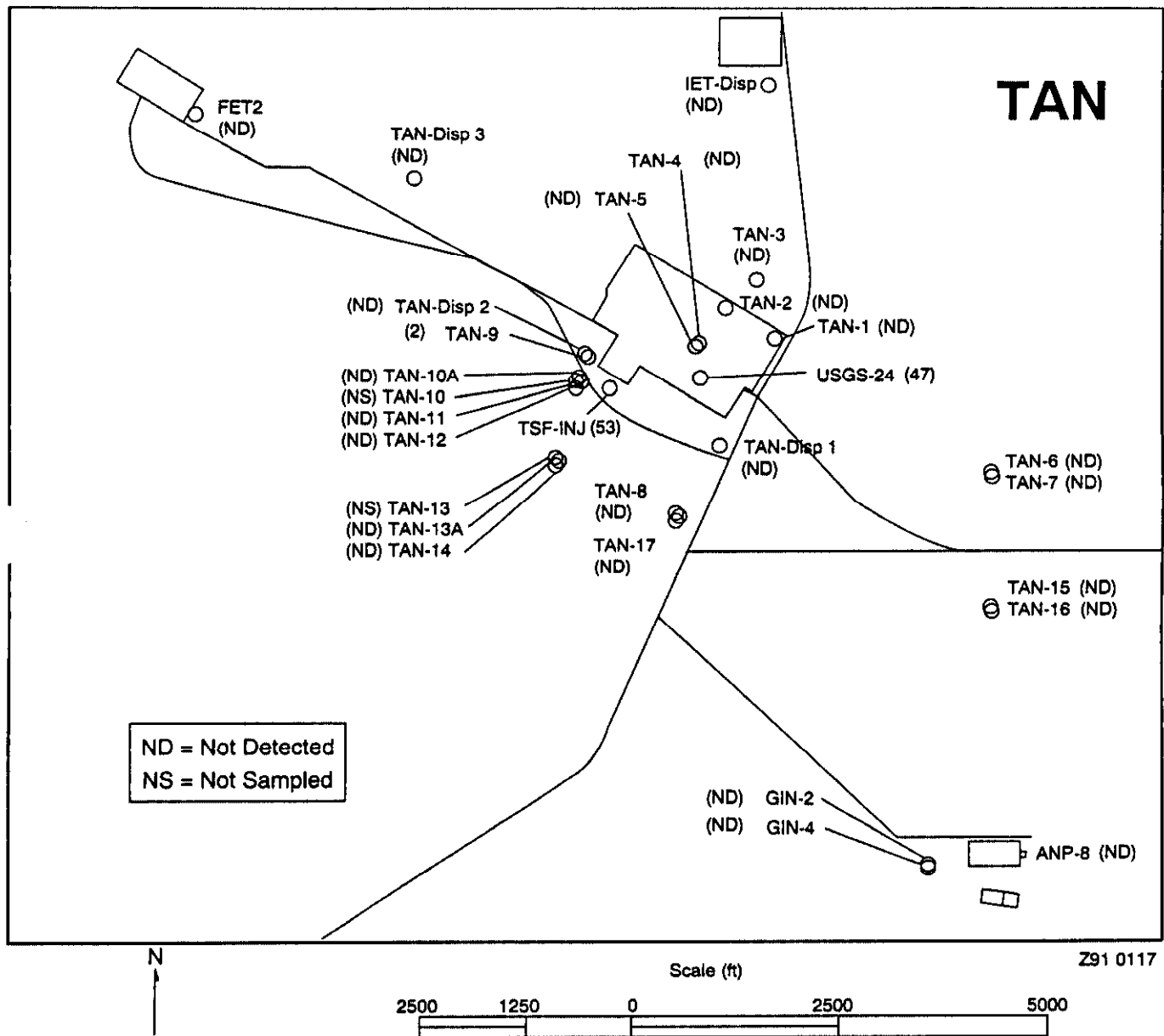
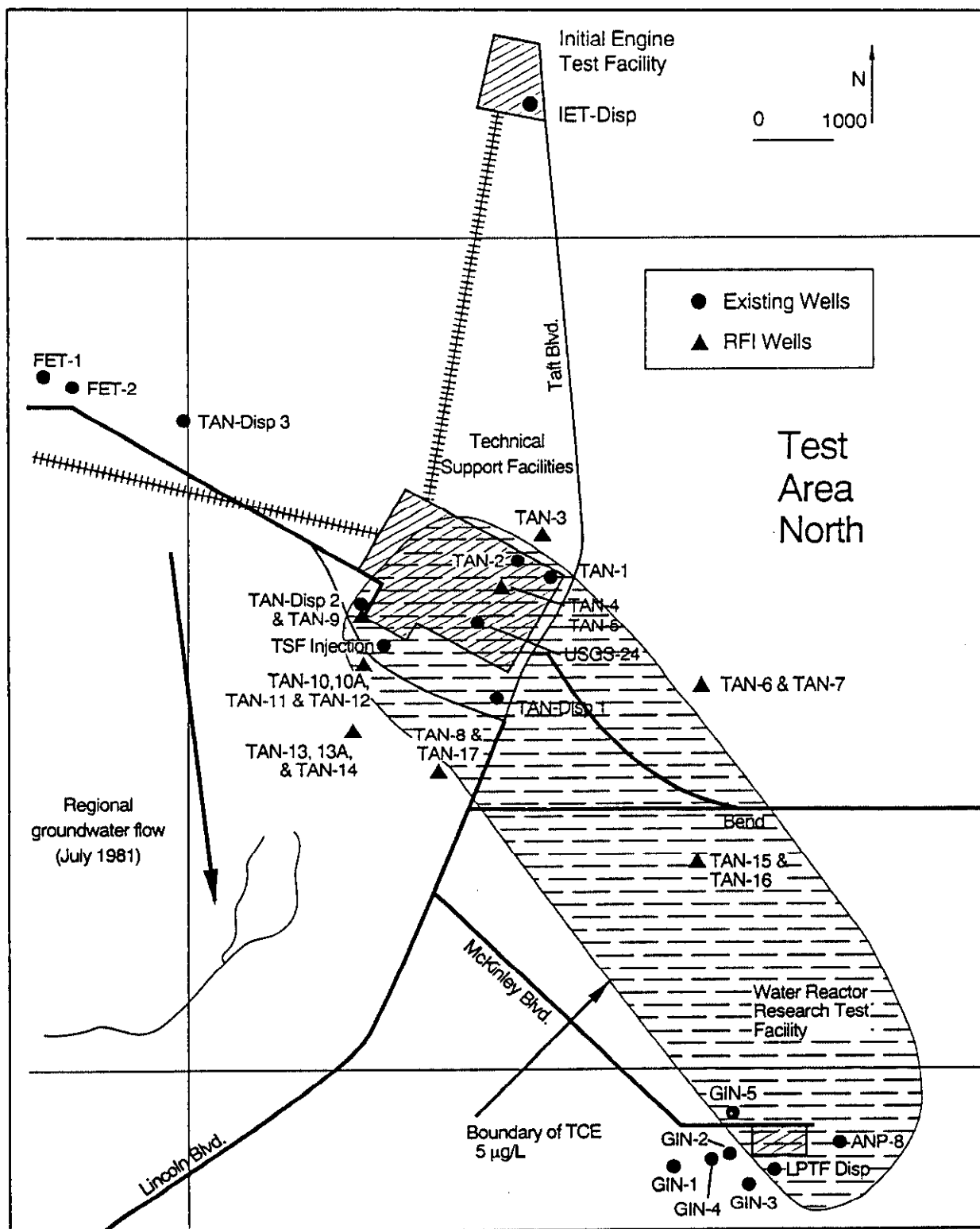


Figure 1-12. Distribution and concentration of 1,2-DCE (total) - FY-90
(concentrations shown in () are in $\mu\text{g/L}$).



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Figure 1-13. General configuration of the TCE plume - FY-90.

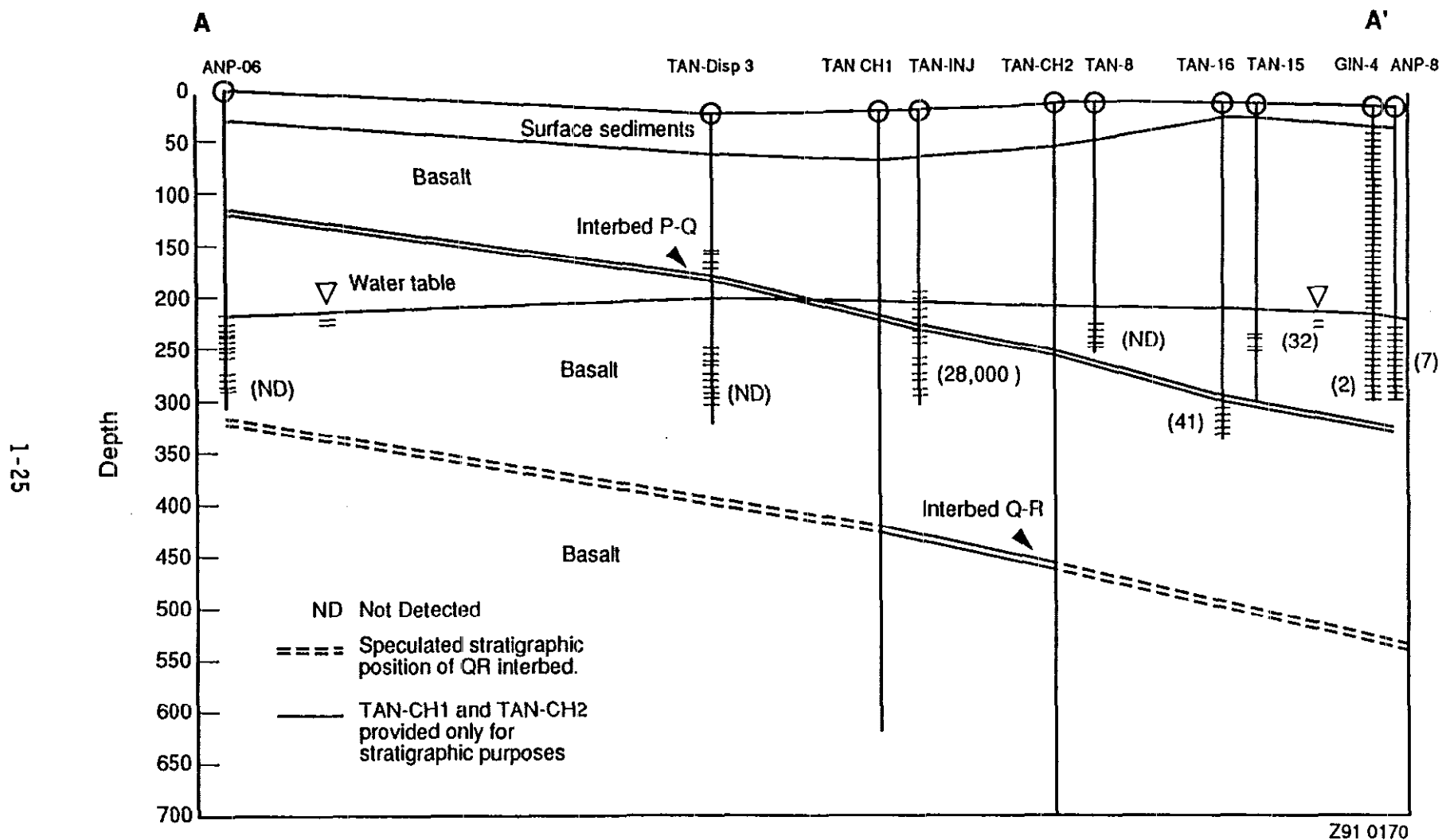
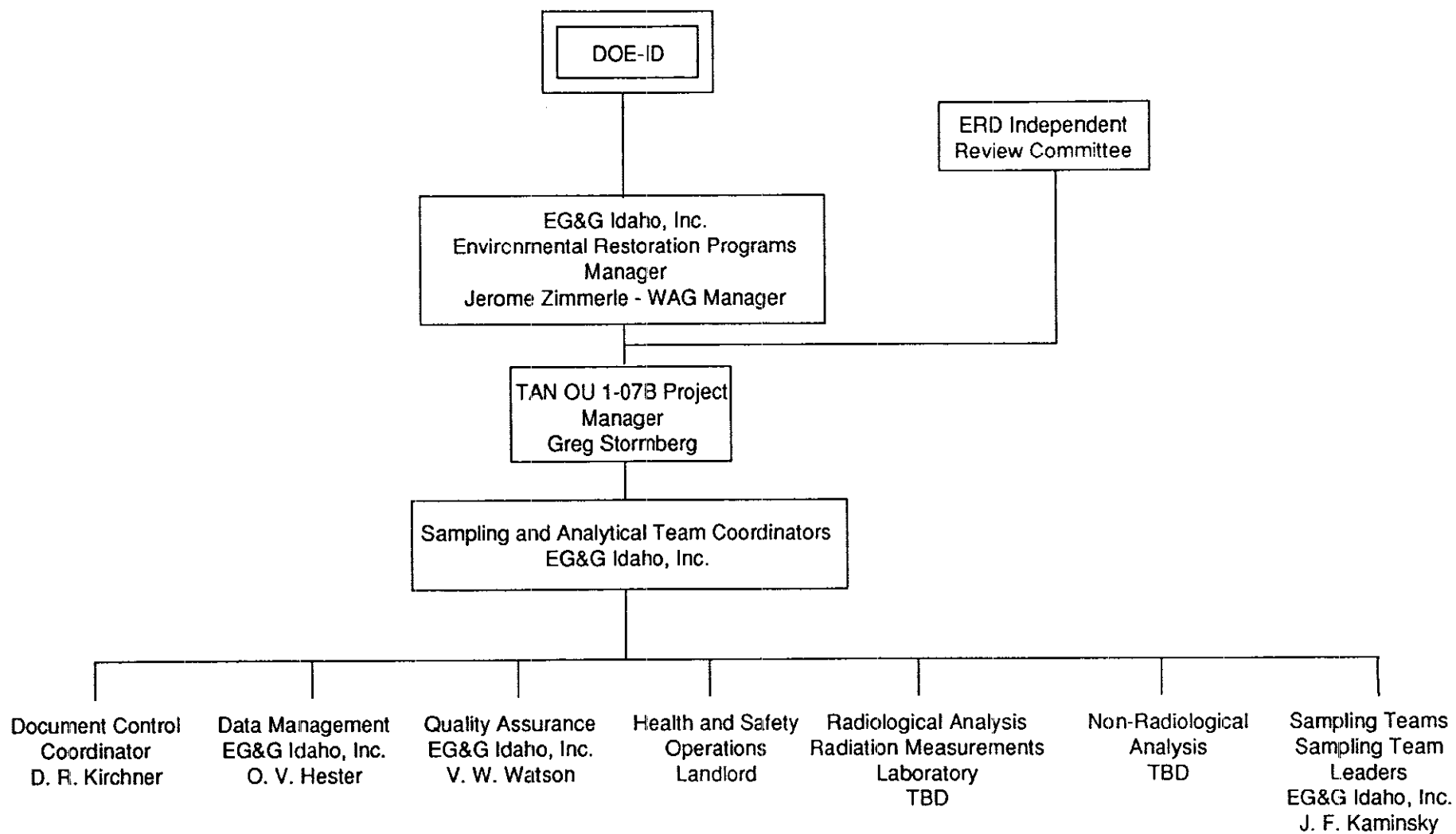


Figure 1-14. Northwest-southeast cross-section through TAN showing completion intervals of wells and associated TCE concentration ($\mu\text{g/L}$) from the FY-90 sampling event.



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Figure 1-15. Organization chart for the TAN Groundwater Operable Unit.

2. SAMPLING OBJECTIVES AND MEDIA SPECIFIC RATIONALE

2.1 DATA NEEDS AND DATA OBJECTIVES

This section presents an identification of the data needs required for completing the remedial investigation for the TAN Groundwater RI/FS. This section defines data needs and the data quality objectives (DQOs) for each medium of concern for the TAN RI/FS.

The CERCLA response for the TAN 1-07B RI/FS is focused on groundwater contamination associated with the TSF-05 injection well, the presumed primary source. After each phase of the response, existing data will be evaluated to assess any data gaps that must be addressed prior to initiating subsequent response efforts, and DQOs will be revised accordingly. As the understanding of TAN groundwater conditions improves and the range of potential remedial alternatives is narrowed, data gaps should become more limited.

2.1.1 Data Needs

Data needs have been identified by evaluating existing data and determining what additional data are necessary for site characterization, risk assessment, fate and transport modeling, and development of remedial action alternatives.

The data needs and sampling objectives for the TAN Groundwater RI/FS are provided in Table 2-1. The measurement approach for meeting these data objectives is found in Table 2-2 and was determined based on the intended use of the data.

2.1.2 Decision Making Process

The data quality objectives identified in Tables 2-1 and 2-2 specify the quality of data required to support decisions during the TAN OU 1-07B remedial response process. A variety of analytical methods are available to provide the necessary data.

Table 2-1. Sampling objectives: TAN Groundwater Operable Unit remedial investigation

<u>Sampling Objectives</u>	<u>Data Needs</u>	<u>Data Types</u>
<u>Regional Aquifer</u>		
<ul style="list-style-type: none"> Identify pathways for contaminant movement 	<ul style="list-style-type: none"> Stratigraphy, structure 	<ul style="list-style-type: none"> Geologic logging Geophysical logging
<ul style="list-style-type: none"> Determine movement rate, direction, and dispersion of contaminants so that changes in the plume over time can be modeled. Provide input parameters for fate and transport modelling 	<ul style="list-style-type: none"> Hydrologic conditions Properties of sedimentary interbed Properties of the basalt 	<ul style="list-style-type: none"> Groundwater elevation Aquifer parameters Physical properties Mineralogical and geochemical properties Mineralogical and geochemical properties
<ul style="list-style-type: none"> Determine presence or absence of contaminants and spatial distribution of contaminants 	<ul style="list-style-type: none"> Water quality in new wells drilled as part of the RI 	<ul style="list-style-type: none"> Volatile organics Metals Radionuclides General properties Inorganics
<ul style="list-style-type: none"> Determine presence or absence of contaminants and spatial distribution of contaminants. Determine temporal effects of 1990 sludge removal from the TSF-05 injection well. 	<ul style="list-style-type: none"> Water quality in all existing wells 	<ul style="list-style-type: none"> Volatile organics Metals Radionuclides General properties Inorganics

Table 2-2. Data quality objectives for the remedial investigation of the TAN Groundwater Operable Unit: Snake River Plain Aquifer

<u>Data Type</u>	<u>Measurement Calculation</u>	<u>Analytical Method</u>	<u>Analytical Level Required to Meet DQOs</u>	<u>Data Use^{a,b}</u>
Geological logs	Visual	ASTM D2488-84	I	SC, EA, ED
Geophysical logs	Caliper logging	FSM/FSP	I	SC, EA, ED
	Natural gamma logging	FSM/FSP	I	SC, EA, ED
	Neutron epithermal neutron logging	FSM/FSP	I	SC, EA, ED
	Gamma-gamma (density) logging	FSM/FSP	I	SC, EA, ED
Groundwater elevation	Static water level	FSM/FSP	Vertical ± 0.01 ft or as achievable	SC, EA, ED
Aquifer parameters	Slug tests (standard and pneumatic) and straddle packer pumping tests	FSM/FSP	I	SC, EA, ED
<u>Sedimentary Interbed</u>				
Mineralogical and geochemical properties	X-ray diffraction	ASTM D934-80	III	SC, EA, ED
	Cation exchange capacity	SW846-9081	III	SC, EA, ED
	Total organic carbon	MOSA, Part 2, p. 539	III	SC, EA, ED
Physical properties	Hydraulic conductivity	ASTM D2434, constant head (MOSA p. 694) falling head (MOSA p. 700)	III	SC, EA, ED
	Porosity	ASTM D4531 or MOSA p. 444	III	SC, EA, ED
	Bulk density	ASTM D4531 or MOSA p. 364	III	SC, EA, ED
	Particle size distribution	ASTM D442-63 or MOSA p. 383	III	SC, EA, ED
<u>Basalt</u>				
Mineralogical and geochemical properties	X-ray diffraction	ASTM D934-80	III	SC, EA, ED
	Cation exchange capacity	SW846, 9081	III	SC, EA, ED
<u>Water (remedial investigation wells)</u>				
Chemical constituents and radionuclides	Volatile organics	EPA 524.2	IV	SC, EA, ED, RA
	Metals	CLP	IV	SC, EA, ED, RA
	Radionuclides	RMAT	IV	SC, EA, ED, RA

Table 2-2. (continued)

Data Type	Measurement Calculation	Analytical Method	Analytical Level Required to Meet DQOs	Data Use ^{a,b}
	Additional water quality analysis	See Table 3-9, FSP	III	SC, EA, ED, RA
General properties	pH	FSM/FSP	II	SC
	Conductivity/TDS	FSM/FSP	II	SC
	Temperature	FSM/FSP	II	SC
	Dissolved oxygen	FSM/FSP	II	SC
Chemical constituents (groundwater samples from straddle-packer pumping of isolated zones during drilling)	Volatile organics	SW846-8010	II	SC
<u>Water (existing wells)</u>				
Chemical constituents and radionuclides	Volatiles	EPA 524.2	III	SC, EA, ED, RA
	Metals	CLP (2-88 SOW)	IV	SC, EA, ED, RA
	Radionuclides	RMTA	IV	SC, EA, ED, RA
	Additional water quality analysis	See Table 3-9, FSP	III	SC, EA, ED, RA
General properties	pH	FSM/FSP	II	SC
	Conductivity/TDS	FSM/FSP	II	SC
	Temperature	FSM/FSP	II	SC
	Dissolved oxygen	FSM/FSP	II	SC

a. Analytical data for which CLP protocols are applicable will be Analytical Level IV for use in Evaluation of Alternatives (EA) and risk assessment (RA). Other physical, geologic, chemical, visual, geophysical, radiological, and general properties data designated Analytical Level I, II, III, V may also be used in the EA process. Where practical, non-CLP measurements/methods will include equivalent QA/QC and documentation to meet Analytical Level IV criteria.

b. Geologic, hydrologic, geochemical, mineralogical, and physical property data will be used as input parameters for fate and transport modeling. Groundwater quality data will be used for both the BRA and fate and transport modelling.

Key:

ASTM	- American Society for Testing Materials
CLP	- Contract Laboratory Program
EA	- evaluation of alternatives
ED	- engineering design
EPA 524.2	- volatile organic method found in EPA, 1988
FSM/FSP	- field sampling method found in the Field Sampling Plan
MOSA	- Methods of Soil Analysis (Parts 1 and 2, A. Klute, [Editor], 1986 American Society of Agronomy Inc., Soil Science Society of America, Inc.)
RA	- risk assessment
RMTA	- Radiological Master Task Agreement
SC	- site characterization
TDS	- total dissolved solids

The analytical levels in Table 2-2 were identified to meet intended use. Statements of accuracy and precision for the analytical methods identified in Table 2-2 can be found in the Quality Assurance Project Plan.

Table 2-3 defines five analytical support levels that will be used for this investigation. The analytical levels relate to the location in which the analysis is done (lab vs. field), the sophistication of the analytical method (internal standard operating procedure, EPA approved, or modified approved procedure), and the level of detail with which QA/QC is specified in the SOW to the laboratory and documented in the data package. Individual DQOs and analytical support levels are given in Table 2-2. In general, DQOs for the investigation are intended to obtain data of sufficient quality and quantity to accomplish the following:

- Detect the presence or absence of contaminants in the various media
- Determine the concentration of contaminants to the extent that a comparison can be made to ARARs or other action levels
- Determine site characteristics, contaminant properties, and probable contaminant transport pathways to the degree required to support a preliminary risk assessment.

Figure 2-1 illustrates the decision-making process that will be used following the remedial investigation for groundwater.

2.2 MEDIA-SPECIFIC RATIONALE

2.2.1 Subsurface Sediment Sampling

The potential for TCE and other contaminants being present in sediment/rock matrix of the TSF-05 injection well annular space will be investigated as part of the interim action (see attached addendum). Information obtained from the interim action will be incorporated into evaluations of data from the RI.

Table 2-3. Analytical levels

Level I	Analyses done by on-site instrumentation primarily used for monitoring air for health and safety purposes (e.g., organic vapor monitoring instruments). Limited quantitative information can be gathered along with limited qualitative information (e.g., presence of volatile organics, not which compound is present) (see Reference 1, ERD PD 5.5, "Obtaining Laboratory Services").
Level II	Analyses done by field instrumentation or in a mobile laboratory that provides qualitative as well as quantitative results (e.g., portable x-ray fluorescence or gas chromatograph). Data from these analyses can be used for site characterization and monitoring during remedial activities (see Reference 1, ERD PD 5.5, "Obtaining Laboratory Services").
Level III	Analyses done by any approved laboratory procedure [i.e., approved by American Society for Testing and Materials (ASTM), Environmental Protection Agency (EPA), the ERD Independent Review Committee (EIRC), United States Geological Survey (USGS), etc.]. Data from these analyses can be used to confirm analyses performed by Level II techniques, evaluate engineering design, etc. (see Reference 1, ERD PD 5.5, "Obtaining Laboratory Services").
Level IV	Chemical analyses done by any EPA-approved method or any radiological analyses by method as specified by the Radiological Statement of Work. The laboratory deliverables consist of an EPA Contract Laboratory Program (CLP) type data package or the data package for chemical analyses specified by the Statement of Work for radiological analyses.
Level V	Analyses done by modified approved methods. The EPA Special Analytical Services (SAS) and EIRC approved methods for experimental analyses in unusual matrices are examples of Level V support. These data are also used for decisions requiring the highest level of confidence in the data (see Reference 1, ERD PD 5.5, "Obtaining Laboratory Services").

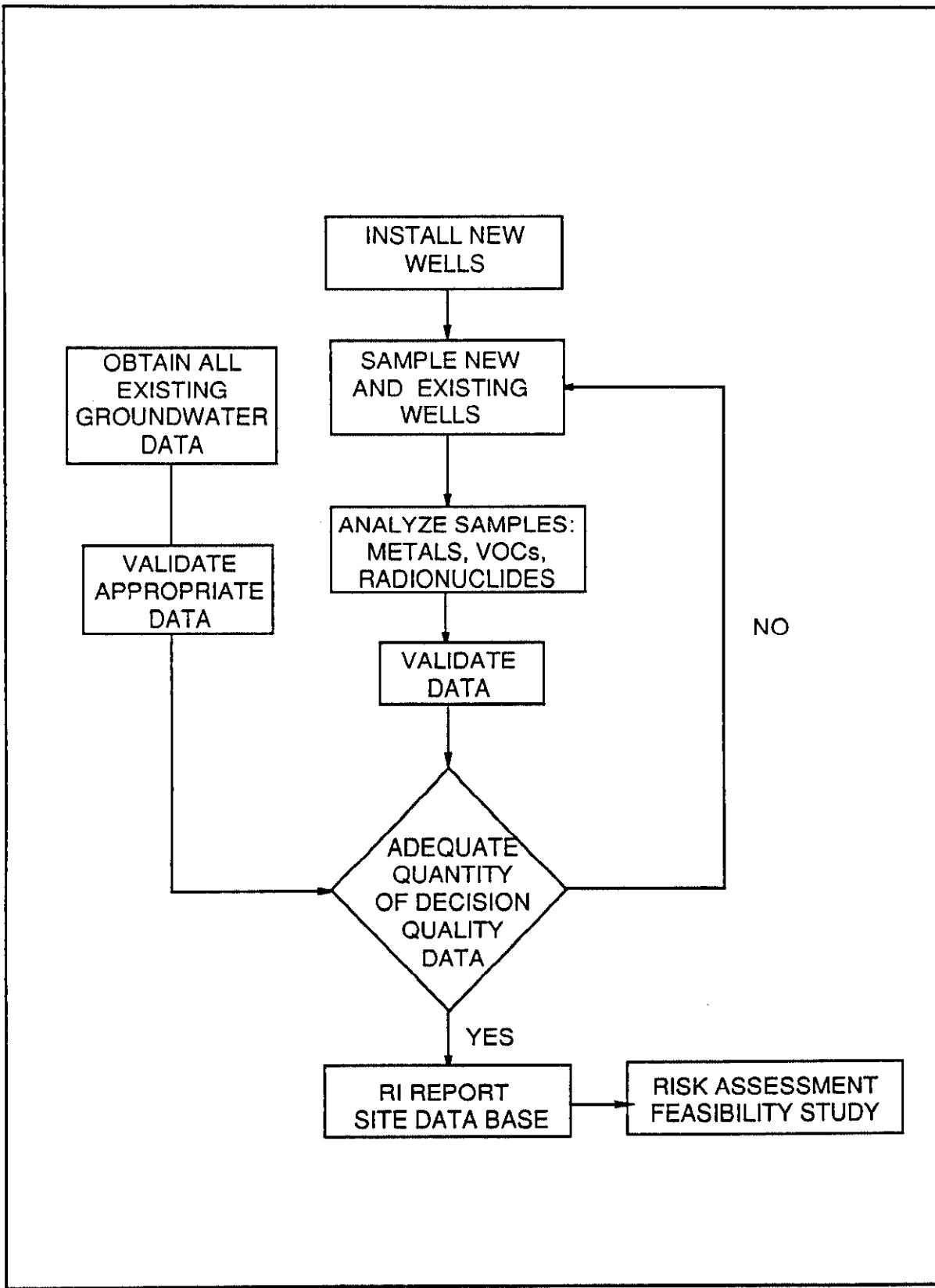


Figure 2-1. Decision tree TAN RI/FS groundwater sampling.

2.2.2 Groundwater

To understand the extent of contamination and to identify the subsurface transport pathways from the TSF-05 injection well and other potential sources at TAN, additional wells will be drilled and sampled. Data collected from these wells will supplement existing information from wells previously drilled and installed during the RFI and by the USGS around TAN. The RI and RFI data will provide the information necessary to define the lateral and vertical extent of contamination, as well as to identify subsurface hydrogeologic factors (i.e., interbeds) influencing the movement of contaminants. While the northern, eastern and western lateral extent of TCE contamination is fairly well known for the shallow part of the aquifer (200-400 ft bls), information on the vertical extent of contamination, the southern (S, SE and SW) lateral extent of contamination, the temporal effects of the 1990 sludge removal action from the injection well on groundwater contaminant concentrations, and subsurface factors potentially influencing the migration of contaminants are unknown. The field investigation strategy developed here was based on assumption that the Federal Drinking Water Standard maximum contaminant level (MCL) of 5 $\mu\text{g/L}$ for TCE defines the extent of the contamination.

The existing USGS wells will be sampled to determine metals, radionuclides, volatile organics, and general groundwater chemistry. Since detailed records of well construction and sample integrity information are not available for all of the existing USGS wells, the data collected from these wells will be analytical support Level III. Wells drilled and installed as part of the RFI will also be sampled. Because analytical support Level IV data were collected during FY-89 and FY-90, only analytical support Level III data (metals will be Level IV) will be collected during FY-92. Groundwater quality data from the existing wells will be used for contaminant fate and transport modeling, risk assessment evaluations, and for contaminant trend analysis to evaluate the temporal effects on groundwater quality of the TSF-05 injection well sludge removal action in 1990.

Groundwater quality data collected from the new RI wells will be analytical support Level IV and will be used, along with existing data, for trend analysis and remedial action decisions, and if necessary, for contaminant fate and transport and risk assessment evaluations.

Seven wells will be completed in the Snake River Plain Aquifer as part of the RI. Four of the wells will be installed as cluster well pairs (i.e., TAN-18 and TAN-19; TAN-22 and TAN-23) and three wells (TAN-20, TAN-21, and TAN-24) will be installed as single completion wells. During drilling, samples of the P-Q and Q-R sedimentary interbeds will be collected from the deep borehole of each cluster pair. These samples will be analyzed to determine physical, hydrologic, and geochemical properties that may affect the migration of contaminants. Straddle-packer pumping tests will be performed on, and groundwater samples will be collected for analysis from highly porous or fractured zones as drilling progresses in each of the deep boreholes (TAN-19 and TAN-23) and in the single completion wells TAN-20, TAN-21, and TAN-24. Straddle-packer pumping tests and groundwater sampling will also be carried out during the drilling of TAN-18 and TAN-22 (shallow cluster wells), but to a more limited extent than in the adjacent deep borehole.

Water quality data, along with geophysical, geological, and hydrogeological data, will be used as the basis for determining well completion depths. These data will also be used as input to numerical models to determine the rate and extent of contaminant movement.

The drilling, geological/geophysical logging, hydrologic testing, and groundwater sampling/analysis of monitoring wells will fulfill the following objectives:

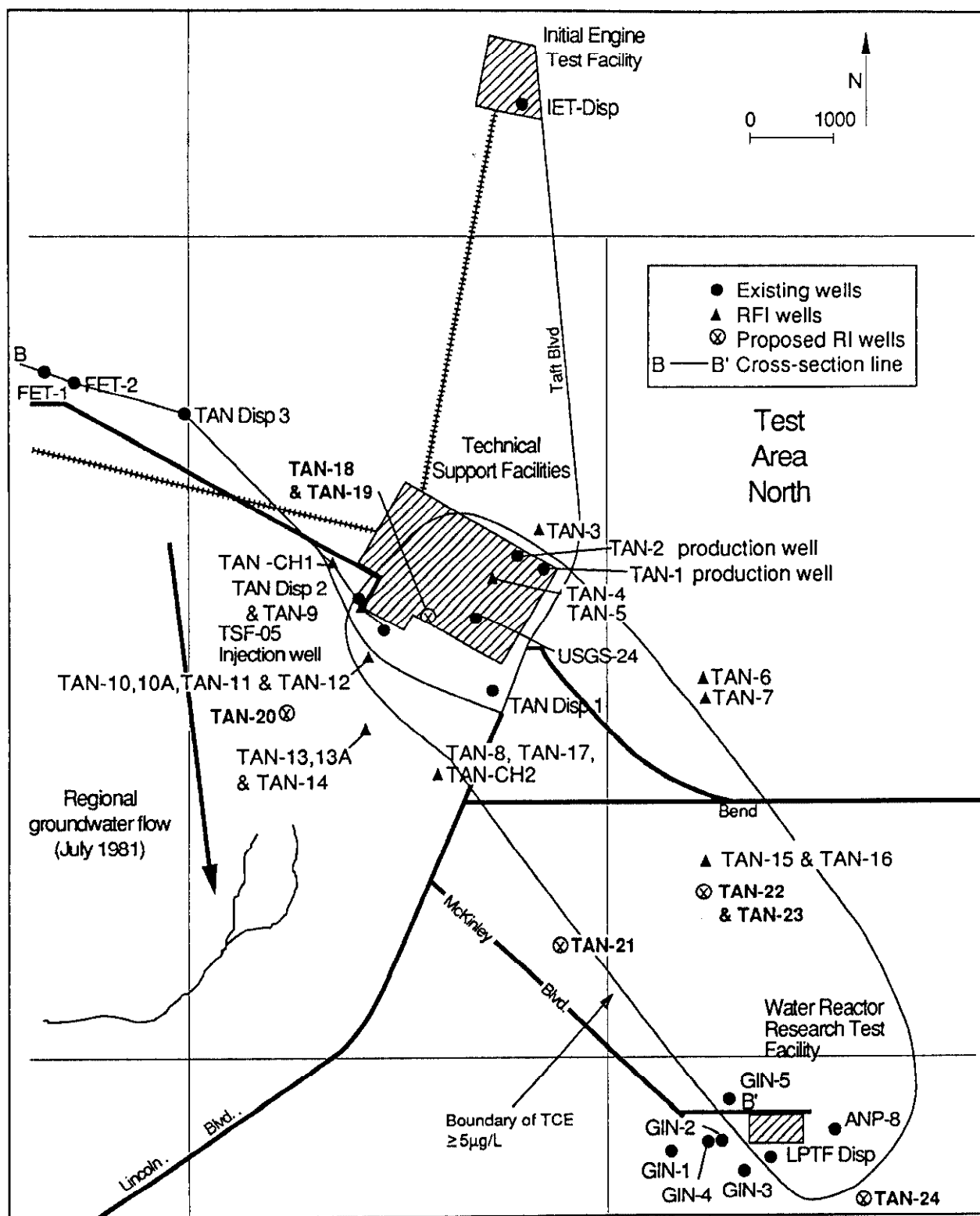
- Provide detailed information on the subsurface stratigraphy and structure
- Provide additional piezometric control points
- Provide additional water chemistry data and sampling points for contaminants
- Provide information to better define the vertical and horizontal hydraulic gradients
- Provide physical, hydrologic, and geochemical characterization of interbeds and basalts
- Provide information on the nature and vertical and southern lateral extent of contamination in the groundwater
- Identify movement pathways.

The potential for residual DNAPL in the vicinity of the TSF-05 injection well will be evaluated using information obtained from both the proposed interim action and RI activities. Remedial investigation activities (well drilling, groundwater sampling, and existing data evaluation) will provide water quality and stratigraphic information (i.e., presence and continuity of interbeds) for use in this evaluation.

2.2.2.1 Snake River Plain Aquifer Wells. The intent of the regional aquifer monitoring scheme is to place wells at TAN in the areas that have the highest potential for detecting migrating contaminants and for providing definition of both the vertical and southern lateral extent of contamination. The criteria used for the selection of aquifer well locations included the following: (a) the location of the presumed source of the contaminants, (b) the regional and local groundwater flow direction, and (c) locations where existing groundwater monitoring wells are not of sufficient depth to define the vertical extent of TCE contamination. The locations of the new aquifer characterization wells are expected to detect contaminants that have entered the regional aquifer following the current understanding of the conceptual model. Figure 2-2 shows the locations of both the existing and new RI monitoring wells at TAN. In general, the rationale for well placement is that while the northern, eastern, and western horizontal extent of contamination is fairly well constrained for the shallow (200–350 ft bls) part of the aquifer, the southern lateral extent (on the SW, S, and SE) is not defined and the vertical extent of contamination is poorly understood with respect to both lateral extent and potential migration constraints resulting from deep subsurface hydrogeology. As was discussed in Section 2.1.6.6 of the Work Plan, the Q-R interbed may be laterally continuous, and therefore, may act as a confining layer with respect to the vertical migration of contaminants.

The specific criteria used to locate each characterization well are as follows:

- The location of cluster well pair TAN-18 and TAN-19 was selected between the presumed source of contamination (TSF-05 injection well) and wells USGS-24, TAN-1, and TAN-2. The location is hydraulically cross-gradient from the injection well based on regional groundwater flow and is down-gradient based on local groundwater flow resulting from water supply well pumping (TAN-1 and TAN-2). TAN-18 and TAN-19



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Figure 2-2. Locations of proposed and existing Snake River Plain Aquifer wells at TAN.

will provide information on the vertical extent of TCE contamination beneath the TSF, as well as information on the presence/continuity of subsurface interbeds.

- Monitoring well TAN-20 will be drilled and installed southwest of the TSF-05 injection well (west of TAN-13A and TAN-14). The location of this well will provide information on a) the potential presence and extent of TCE contamination southwest of the injection well and b) whether or not contaminants are being dispersed along a south-southwest groundwater flow path not subject to pumping influence of the TSF production wells. Additional information will be obtained on subsurface stratigraphy and groundwater flow parameters.
- Well TAN-21 will be drilled and installed approximately midway between the TSF-05 injection well and GIN-5 at WRRTF. It is located just south of the postulated southern extent of TCE contamination. TAN-21 will provide information on the extent of contamination at the southern edge of the contaminant plume. The completion depth of TAN-21 will be determined from the results of groundwater sampling and analysis during the drilling program. The completion interval will be in the last (deepest) zone where TCE is detected $\geq 5\mu\text{g/L}$. Additional information will be obtained on groundwater flow parameters and the stratigraphy/structure in the area.
- The proposed location of well cluster TAN-22 and TAN-23 is down-gradient from the TSF-05 injection well and adjacent to shallow monitoring wells TAN-15 and TAN-16. Both TAN-15, which is screened above the P-Q sedimentary interbed at approximately 250 ft bls, and TAN-16 (screened just below the interbed), have similar groundwater concentrations of TCE (see Figure 1-14). Well completion depths will be based on groundwater analysis during the drilling process. TAN-22 will be completed at the leading (vertical) edge of the TCE plume. TAN-23 will be completed in the first permeable zone below TAN-22 where TCE concentrations are $< 5\mu\text{g/L}$. Additional information will be obtained on groundwater flow parameters, interbed geochemistry and physical properties, and the stratigraphy/structure in the area.
- Well TAN-24 will be drilled and installed south-southeast (down gradient) of production well ANP-8 at WRRTF. This well will provide information on the southeastern extent of contamination by providing a monitoring point down gradient from the WRRTF area. Information on subsurface stratigraphy and groundwater flow in the area will also be obtained. TAN-24 will be completed in the last (deepest) zone where TCE is detected $\geq 5\mu\text{g/L}$.

2.2.2.2 Aquifer Testing and Groundwater Sampling During Drilling. To accurately define or identify the vertical extent of TCE and to obtain information on the aquifer characteristics, an aquifer testing and groundwater

sampling program will be conducted during the drilling process (aquifer parameters calculated for TAN are shown in Table 2-4). Testing and sampling for the deep borehole of each cluster (TAN-19 and TAN-23) will commence at the first permeable zone encountered at a depth below the completion interval of the nearest already existing well. Aquifer testing and groundwater sampling will be repeated at selected permeable zones over the entire depth of the borehole, as well as above and below the Q-R sedimentary interbed. Aquifer testing and groundwater sampling in the shallow boreholes of each cluster (i.e. TAN-18 and TAN-22) will also be carried out but to a more limited extent than in the adjacent deep boreholes. Aquifer testing and groundwater sampling for wells TAN-20 and TAN-24 will be as described for the deep cluster wells. However, testing and sampling will not be carried out below the Q-R interbed as it is anticipated that these wells will be completed above the interbed. For well TAN-21, there is no adjacent existing well; therefore, aquifer testing and sampling will commence at the first permeable zone below the water table and will be repeated at selected permeable zones over the entire depth of the borehole to the top of the Q-R interbed. A detailed discussion of this program and related tasks is provided in Section 5.1.4 of this FSP.

2.2.2.3 Slug Testing and Water Level Measurements. All installed characterization wells will be hydraulically tested using either standard or pneumatic slug testing methods. In addition, continuous water level recorders will be installed in selected wells (see Section 5.1.5) to record changes in water levels resulting from production well pumping and to provide information about the hydraulic connection among the wells. Well selection for recorder installation will be based on the locations of monitoring wells with respect to potential pumping well influences, as well as on subsurface geologic information. Water levels in TAN area wells will be measured monthly. These tasks are discussed in detail in Section 5.1.5 of the FSP.

Table 2-4. Aquifer parameters calculated from pumping tests in the Test Area North wells

Well ^f	Pumped Well	Q (gpm)	Open Interval (ft bls)	Water Level (ft bls)	Saturated Length (b')	D = draw down R = recover	Neuman Method		Jacob Method		Average Values ^a	
							T x 100,000 (gpd/ft)	S	T x 100,000 (gpd/ft)	S	T x 100,000 (gpd/ft)	S
TAN-1	TAN-1	1050	200-360	208	152	D R	2.8 ^b 1.3 ^b	^c ^c	2.8 ^b 3.0	^c	2.5	^c
TAN-2	TAN-1	1050	235-335	211	100	D R	0.9 ^b 2.0 ^b	0.003 ^b 0.005 ^b	18.0 26.0	0.003 0.006	1.5	0.004
USGS 24	TAN-1	1050	255-265 270-275 285-375	215	105	D R	11.0 ^b 28.0 ^b	0.003 ^b 0.005	16.0 ^b	0.003 ^b	14.0	0.003
TAN-2	TAN-2	1010	235-335	211	100	D R	0.9 ^b 0.9 ^b	^c ^c	4.8 6.6	^c ^c	0.9	^c
USGS 24	TAN-2	1010	255-265 270-275 285-375	215	105	D R	26.0 ^b 5.5	0.001 ^b 0.01	22.0 ^b 19.0	0.002 ^b 0.01 ^b	21.0	0.002
TAN-1	TAN-2	1010	200-360	208	152	D R	23.0 ^b 23.0 ^b	0.004 ^b 0.004 ^b	22.0 ^b 22.0 ^b	0.004 ^b 0.004 ^b	23.0	0.005
IET-DISP	IET-DISP	19.99	219-319	209	100	D R	d d	^c ^c	0.5 ^b 0.3 ^b	^c ^c	0.4	^c
TSF-inj ^e	TSF-inj	19.70	180-244 269-305	199	81	D R	d d	^c ^c	0.03 ^b 0.03 ^b	^c ^c	0.03	^c

a. Values are based on the average of the reliable pumping test data (see b below).

b. Data values used to estimate T and S.

c. Storativity calculations are unreliable from pumped well.

d. Well bore storage effects.

e. Aquifer coefficients from the TSF injection well may not be indicative of the surrounding aquifer. The materials disposed in the well may have impacted the aquifer's ability to transmit water.

f. See well equivalency table in the Work Plan.

3. SAMPLING LOCATION, FREQUENCY, AND SAMPLING/ANALYTICAL METHODS

The material presented in this section is intended to support the data quality objectives summarized in Section 2. Tables 3-1 and 3-2 provide a summary of the sampling plan and include sample type, media, location, and analyses. Figure 3-1 shows the location of existing aquifer wells from which groundwater samples will be collected. All samples will be contained in laboratory cleaned and certified bottles and packaged according to EPA recommended procedures (see Section 6.2). A minimum of 20% quality assurance samples will be included to satisfy the quality assurance requirements for the field operation [see Quality Assurance Project Plan (QAPjP) for project QA/QC goals], and qualified (ERD-approved) analytical and radiation measurements laboratories will analyze all samples. Field guide forms (see Figure 6-2 in Section 6.1.3) outlining sample collection location, sample numbers, and analysis requested will be provided for each sample location. The forms will be generated from the sampling plan data base, which will ensure unique sample numbers.

All activities outlined in this FSP will be carried out in accordance with applicable health and safety regulations and requirements as discussed in the Health and Safety Plan addendum for this project.

3.1 AQUIFER WELLS

Seven aquifer wells (TAN-18 through TAN-24) will be drilled and installed as part of this investigation. Four of the wells will be constructed as well clusters and three wells will be constructed as single well completion sites. The deep well of each cluster will be drilled and completed before the shallow well is drilled (see Figure 2-2). If possible, interbed samples will be collected from the P-Q and Q-R interbeds in the deep borehole of each cluster (see Figures 1-5 and 1-6 for interbed stratigraphy). These samples will be analyzed for physical, hydrologic, and geochemical properties as listed in Tables 2-2, 3-1, 3-7, and 3-8 and in Section 3.4. Additionally, a straddle-packer pump assembly will be used to perform pumping tests and to collect groundwater samples during the drilling process. The objective is to collect hydrologic data and groundwater quality data from permeable/fractured

Table 3-1. Summary of location, media, sample type, and analysis--core and interbed samples

<u>Location</u>	<u>Media</u>	<u>Sample Type</u>	<u>Physical^a Properties</u>	<u>Mineralogical^b Geochemical</u>	<u>Comments</u>
Existing Core holes					
• TAN-CH1	Basalt	Core		2 ^c	As needed for characterization
• TAN-CH2	Basalt	Core		2 ^c	
TAN-19	P-Q interbed	Core/Shelby	1	1 ^d	Quantities Permitting
	Q-R interbed	Core/Shelby	1	1 ^d	
TAN-23	P-Q interbed	Core/Shelby	1	1 ^d	
	Q-R interbed	Core/Shelby	1	1 ^d	
TOTAL			4	8	

a. Physical properties listed in Table 3-7.

b. Mineralogical and geochemical properties listed in Table 3-8.

c. Mineralogy by x-ray diffraction and CEC only.

d. Mineralogy by x-ray diffraction, CEC, and total carbon.

Table 3-2. Summary of location, sample type, and analysis-groundwater^a

<u>Location</u>	<u>Sample Type</u>	<u>Level IV Volatiles (524.2)</u>	<u>Level III Volatiles (524.2)</u>	<u>Level II Volatiles SW846-8010</u>	<u>Level IV CLP Inorganics Metals</u>	<u>Level IV Radionuclides^b</u>	<u>Additional Water Quality Analytes^c</u>
Existing USGS and RFI wells	Grab	--	30	--	30	30	30
New RI Wells	Grab	7	--	--	7	7	7
Groundwater-new wells, collected during drilling	Grab	--	--	63	--	--	--
TOTAL	--	7	30	63	37	37	37

a. QA/QC samples provided in Table 3-5.

b. Radionuclides to be determined are listed in Table 3-12.

c. See Table 3-9 of this FSP for additional water quality analyses to be conducted.

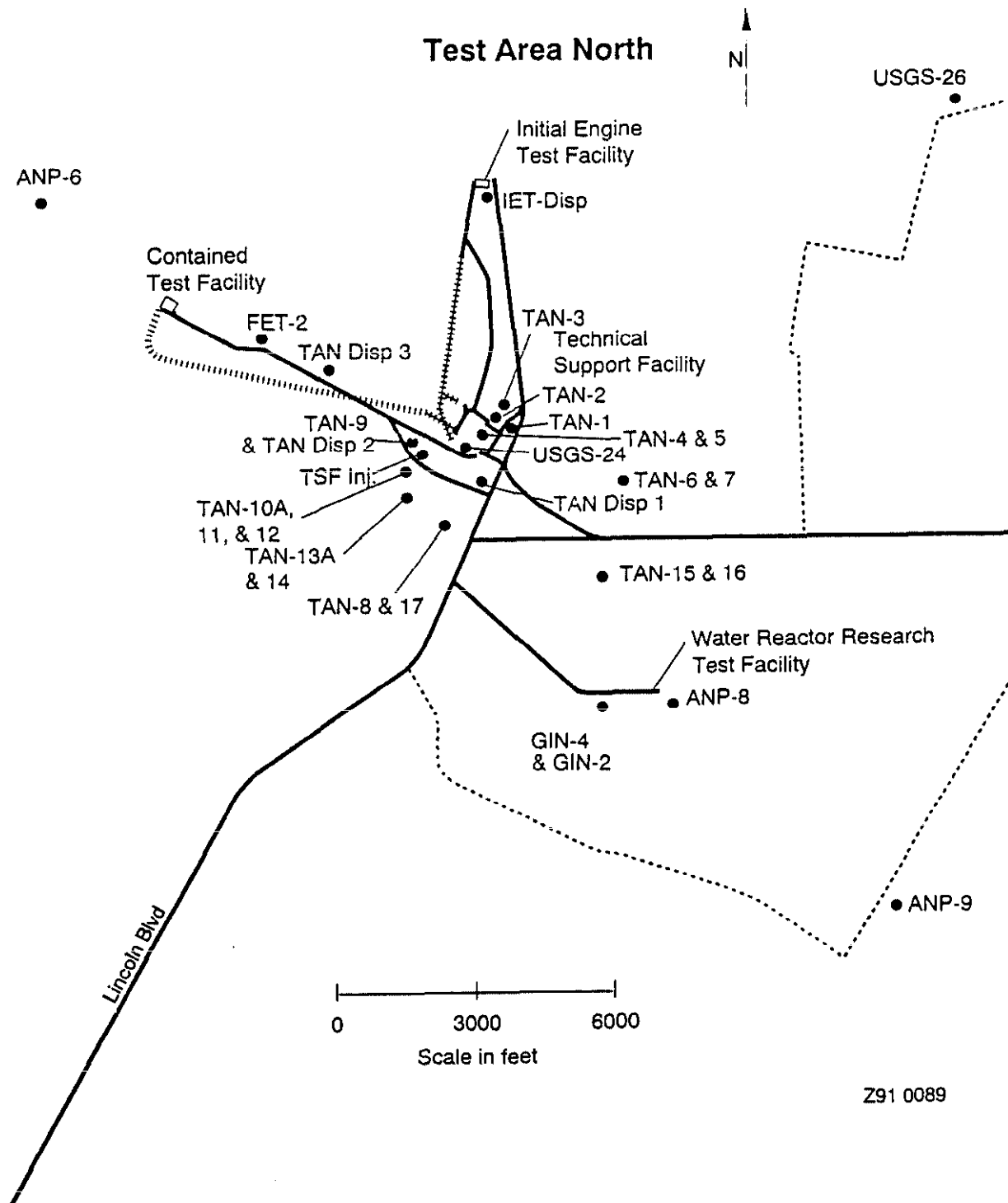


Figure 3-1. Location of existing aquifer wells to be sampled.

intervals in the drill hole. Based on the current understanding of the subsurface stratigraphy at TAN, the Q-R interbed may act as a "barrier" or semi-confining layer, thus inhibiting the vertical migration of contaminants. In general, drilling, groundwater sampling, and hydrologic testing will continue to a depth where the groundwater is below the drinking water standard for TCE ($5 \mu\text{g/L}$). However, this assumes a maximum completion depth of approximately 500 to 550 ft. The need for additional wells will be evaluated if TCE at levels $\geq 5 \mu\text{g/L}$ persists to 550 ft and if the vertical extent of TCE above the drinking water standard is not determined with the new wells. Although actual well completion depths will depend on the results of the "progressive depth" groundwater analysis as well as geologic/geophysical logging, tentative completion depths are provided in Table 3-3.

3.2 GROUNDWATER SAMPLING

3.2.1 Existing Wells

Well-defined and documented quality control and construction procedures utilized by the USGS during the installation of the existing USGS monitoring and observation wells are not always available; therefore, analytical support Level III data will be obtained for the groundwater samples collected from these wells. Samples will be collected for volatile organics, metals, radionuclides, and other water quality parameters.

Existing wells installed as part of the RFI in FY-89 and FY-90 will also be sampled for volatile organics, metals, radionuclides, and other water quality parameters. Two years of analytical support Level IV groundwater data exist for most of these wells. Therefore, additional groundwater samples only need to meet analytical support Level III criteria (except metals, which will be Level IV) and will be used for trend analysis and fate and transport modeling and, if necessary, risk assessment evaluations. The trend analysis is important for determining the temporal effects, if any, on groundwater contaminant concentrations from the removal of sludge from the TSF-05 injection well in 1990.

Table 3-3. Approximate depths of the P-Q and Q-R interbeds, aquifer testing and groundwater sampling depths, and completion depths for the monitoring wells

Well	P-Q Interbed (ft bls)	Q-R Interbed (ft bls)	Initial Aquifer Testing and Sampling Depths (ft bls)	Additional Aquifer Testing and Sampling Depths (ft bls)	Completion Depth of Nearest Existing well (ft bls)	Approximate Completion Depth (ft bls)
TAN-18	200	415	415	NA	TSF-05 269-305	395-415
TAN-19 (deep)	200	415	340	380, 415, 450	TSF-05 269-305	430-450
TAN-20	195	415	415	NA	TAN-12 362-382	395-415
TAN-21	260	450	240	290, 340, 390, 450	NA NA	430-450
TAN-22	260	450	450	NA	TAN-16 302-322	430-450
TAN-23 (deep)	260	450	355	400, 450, 480	TAN-16 302-322	460-480
TAN-24	330	520	325	375, 425, 475, 520	ANP-8 302	500-520

The existing wells to be sampled are listed in Table 3-4. Analyses to be performed will include EPA 524.2 for volatile organics, CLP metals, and radionuclides as listed in Tables 3-6 and 3-10 to 3-12. Additional water quality parameters will be measured and are listed in Table 3-9.

3.2.2 New Wells

For the newly constructed RI monitoring wells (TAN-18 through TAN-24), samples will be analyzed to meet analytical support Level IV criteria. Analyses to be performed will include EPA 524.2 for volatile organics, CLP metals, and radionuclides as listed in Tables 3-6 and 3-10 to 3-12. Additional water quality parameters will be measured and are listed in Table 3-9. Analytical data from these wells, along with data from the existing wells, will be used for fate and transport modeling and remedial action decisions, and, if necessary, risk assessment evaluations.

3.2.3 Sample and Analysis Plan Tables

Sample and Analysis Plan tables for the chemical and radiological analyses are provided in Appendix A of the FSP. QA/QC samples to be collected during groundwater sampling are also identified (also see Table 3-5). These tables will aid in the sample labelling and tracking.

Table 3-4. Existing wells to be sampled^a

<u>USGS Wells</u>	<u>RFI Wells</u>
USGS-24	TAN-3
USGS-26	TAN-4
ANP-6	TAN-5
ANP-8	TAN-6
ANP-9	TAN-7
IET-injection	TAN-8
TAN Disposal 1	TAN-9
TAN Disposal 2	TAN-10A
TAN Disposal 3	TAN-11
TAN-1	TAN-12
TAN-2	TAN-13A
FET-2	TAN-14
TSF-05 injection	TAN-15
GIN-4	TAN-16
GIN-2	TAN-17

a. The wells will be sampled in order beginning with the least contaminated and ending with the most contaminated (e.g., TSF-05 injection well). Sampling order will be based on existing data.

Table 3-5. QA/QC samples for groundwater (also see Sampling and Analysis Plan tables in Appendix A)

Well	Type	Quantity	Comment
Existing RFI and USGS wells	Replicates	4	<ul style="list-style-type: none"> The IET-Disp, is identified as a potential source of groundwater contaminants. Furthermore, TCE was detected in 1987 at 1.3 $\mu\text{g/L}$, but has not been detected in subsequent sampling. TAN-6 represents one of the wells defining the eastern lateral extent of the TCE plume. Only a VOC replicate will be collected from TAN-6. TAN-1 is one of the TSF production wells where TCE has been detected $\geq 5\mu\text{g/L}$. The TSF-05 injection well is the primary source of contaminants and has not been sampled since 55 ft of sludge was removed in 1990.
	Rinsate	1	<ul style="list-style-type: none"> One rinsate sample will be collected for analysis after the first existing well has been sampled, the equipment decontaminated, and prior to sampling the next existing well. This will provide information on the effectiveness of the decontamination procedure early in the sampling program.
	Field Blank	1	<ul style="list-style-type: none"> One of the field blank will be collected just prior to sampling one of the existing wells located near the TSF-05 injection well.
New RI wells	Replicate	2	<ul style="list-style-type: none"> The remedial investigation wells (TAN-18 through TAN-24) are being drilled to define the vertical and southern lateral extent of contamination. Confirmation of results is considered important. At least one sample per well per sampling event is considered critical. Replicates will be collected from TAN-19 and TAN-24.
	Rinsate	1	<ul style="list-style-type: none"> One rinsate sample will be collected after the first time equipment is decontaminated.
	Field Blank	1	<ul style="list-style-type: none"> One field blank will be submitted for analysis.

Table 3-5. (continued)

Well	Type	Quantity	Comment
Groundwater sampling during RI borehole drilling	Triplicate	21	• Triplicate samples will be collected from each straddle-packer test zone. The results of these analysis will be used to determine the vertical distribution of TCE at concentrations \geq and $<$ the drinking water standard of 5 $\mu\text{g/L}$. At least one sample of each triplicate is considered critical.
	Rinsate	1	• One rinsate will be collected.
	Field Blank	1	• One field blank will be collected

Note: Existing and new wells are considered as one sampling event (37 wells), with the groundwater samples collected during drilling as another event. Trip blanks will be collected as described earlier. Trip blanks are included in the sampling program as listed in Appendix A.

Wells selected for replicate analysis pertain only to the first sampling event in April, 1992. Replicates for the second sampling event (October-November, 1992) are identified in the sampling and analysis plan tables in Appendix A.

Table 3-6. Laboratory analytical protocols/chemical analytes

Measurement Parameter	Analytical Method	Comments
<u>Liquids</u>		
Volatiles	EPA 524.2 ^a	Specify target analyte list to laboratory in statement of work (SOW). Tentatively identified compounds (TICs) specified in the analytical SOW will be reported
Sulfates	EPA 300	
Chloride	EPA 300	
Fluoride	EPA 300	
Alkalinity	SM 403 ^b	
Nitrate/Nitrite	EPA 300	
CLP Metals	EPA CLP ^c	
Volatiles	SW 846-8010 ^d	

a. Methods for the Determination of Organic Compounds in Drinking Water (U.S. Environmental Monitoring Systems Laboratory, Cincinnati, OH, December 88, EPA 600/4-88/039).

b. Standard Methods for the Examination of Water and Waste Water, 17th ed., 1989).

c. EPA Contract Lab Program Statement of Work for Inorganics Analysis, Multimedia, Multiconcentration, (SOW No. 788, incl. Rev. 2/89 and 6/89).

d. All SW-846 referenced methods can be found in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846, third edition).

Table 3-7. Physical properties

Measurement Parameter (method)	Reference	Experimental Conditions
Saturated hydraulic conductivity Constant head method Falling head method	ASTM D2434 or MOSA p. 694 MOSA p. 700	Undisturbed sample
Porosity	MOSA p. 444 or ASTM D4531	
Bulk density	MOSA p. 364 or ASTM D4531	Undisturbed sample
Particle size distribution Mechanical sieve Hydrometer	MOSA p. 383 or ASTM 422-63	Sample may be disturbed

MOSA--Methods of Soil Analysis, Part 1, Physical and Mineralogical Methods,
A. Klute (Editor), 1986, American Society of Agronomy, Inc., Soil Science
Society of America, Inc.

ASTM, "1986 Annual Book of ASTM Standards," Vol. 04.08 Soil and Rock; Building
Stones, American Society for Testing and Materials, 1986.

Table 3-8. Mineralogical and geochemical properties

Measurement Parameter (method)	Reference	Experimental
Total organic carbon	Part 2 MOSA p. 539	May be disturbed; has not been sieved
Mineralogic (x-ray diffraction)	ASTM D934-80	< 35 mesh
Cation Exchange Capacity (CEC)	SW-846 9081	May be disturbed; has not been sieved

MOSA--Methods of Soil analysis, Part 1 and 2, A. Klute (Editor), 1986,
American Society of Agronomy, Inc., Soil Science Society of America, Inc.

Table 3-9. Additional water quality analyses

<u>Analyze</u>	<u>Field Measurement</u>	<u>Method</u>
Alkalinity	--	SM 403 ^a
Nitrate and nitrite	--	EPA 300
Sulfate	--	EPA 300
Chloride	--	EPA 300
Fluoride	--	EPA 300

a. Standard Methods for the Examination of Water and Waste Water, 17th ed., 1989. Alkalinity measurements will provide information on carbonated bicarbonate concentrations.

Table 3-10. CLP inorganic target analyze list

Analyze	Contract Required Detection Limit ($\mu\text{g/L}$)
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	3
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
Cyanide	10

Table 3-11. USEPA Method 524.2 (Rev. 3.0) target analyte list and method detection limits*

Volatiles	CAS Number	Method Detection Limits**	
		Wide Bore Column ug/L	Narrow Bore Column ug/L
1. Dichlorodifluoromethane	75-71-8	0.10	0.11
2. Chloromethane	74-87-3	0.13	0.05
3. Vinyl Chloride	75-01-4	0.17	0.04
4. Bromomethane	74-83-9	0.11	0.06
5. Chloroethane	75-00-3	0.10	0.02
6. 1,1-Dichloroethene	75-35-4	0.12	0.05
7. Methylene Chloride	75-04-2	0.03	0.09
8. trans-1,2-Dichloroethene	156-60-5	0.06	0.03
9. 1,1-Dichloroethane	75-34-3	0.04	0.03
10. 2,2-Dichloropropane	590-20-7	0.35	0.05
11. cis-1,2-Dichloroethene	156-69-4	0.12	0.06
12. Chloroform	67-66-3	0.03	0.02
13. Bromochloromethane	74-97-5	0.04	0.07
14. 1,1,1-Trichloroethane	71-55-6	0.08	0.04
15. Carbon Tetrachloride	56-23-5	0.21	0.08
16. 1,1-Dichloropropene	563-58-6	0.10	0.02
17. Benzene	71-43-2	0.04	0.03
18. 1,2-Dichloroethane	107-06-2	0.06	0.02
19. Trichloroethene	79-01-6	0.19	0.02
20. 1,2-Dichloropropane	78-87-58	0.04	0.02
21. Bromodichloromethane	75-27-4	0.08	0.03
22. Dibromomethane	74-95-3	0.24	0.03
23. trans-1,3-Dichloropropene	10061-02-6	ND	ND
24. Toluene	108-88-3	0.11	0.08
25. cis-1,3-Dichloropropene	10061-01-5	ND	ND
26. 1,1,2-Trichloroethane	79-00-5	0.10	0.03
27. Tetrachloroethene	127-18-4	0.14	0.05
28. 1,3-Dichloropropane	142-28-9	0.04	0.04
29. Dibromochloromethane	124-48-1	0.05	0.07
30. 1,2-Dibromoethane	106-93-4	0.06	0.02
31. Chlorobenzene	108-90-7	0.04	0.03
32. 1,1,1,2-Tetrachloroethane	630-20-6	0.05	0.04
33. Ethylbenzene	100-41-4	0.06	0.03
34. Xylene (total meta & para)	1330-20-7	0.13	0.06
35. Xylene (ortho)	95-47-6	0.11	0.06

Table 3-11. (continued)

Volatiles	CAS Number	Method Detection Limits**	
		Wide Bore Column ug/L	Narrow Bore Column ug/L
36. Styrene	100-42-5	0.04	0.06
37. Bromoform	75-25-2	0.12	0.20
38. Isopropylbenzene	98-82-8	0.15	0.10
39. 1,1,2,2-Tetrachloroethane	79-34-5	0.04	0.20
40. Bromobenzene	108-86-1	0.03	0.11
41. 1,2,3-Trichloropropane	96-18-4	0.32	0.03
42. n-Propylbenzene	103-65-1	0.04	0.06
43. 2-Chlorotoluene	95-49-8	0.04	0.05
44. 1,3,5-Trimethylbenzene	108-67-8	0.05	0.02
45. 4-Chlorotoluene	106-43-4	0.06	0.05
46. tert-Butylbenzene	98-06-6	0.14	0.33
47. 1,2,4-Trimethylbenzene	95-63-6	0.13	0.04
48. sec-Butylbenzene	135-98-8	0.13	0.12
49. 1,3-Dichlorobenzene	541-73-1	0.12	0.05
50. 1,4-Dichlorobenzene	106-46-7	0.03	0.04
51. n-Butylbenzene	104-51-8	0.11	0.03
52. 1,2-Dichlorobenzene	95-50-1	0.03	0.05
53. 1,2-Dibromo-3-chloropropane	96-12-8	0.26	0.05
54. 1,2,4-Trichlorobenzene	120-82-1	0.04	0.20
55. Hexachlorobutadiene	87-68-3	0.11	0.04
56. Naphthalene	91-20-3	0.04	0.04
57. 1,2,3-Trichlorobenzene	87-61-6	0.03	0.04

* Method detection limits are those published in the method and may not be achievable in all laboratories (see the Introduction to this Section).

** Method 524.2 is applicable to water samples only. The Method Detection Limits are listed for wide bore and narrow bore capillary columns. A wide bore capillary column is defined as having a internal diameter of greater than 0.32 mm. The data for the narrow bore column was obtained using the cryogenic trapping option in the method.

ND Not Determined for this compound. Use the laboratory determined MDL for reporting.

Table 3-12. Methods for the determination of radionuclides^a

<u>Radionuclide</u>	<u>Technique^b</u>
Americium-241	GS
Antimony-125	GS
Cerium-144	GS
Cesium-134	GS
Cesium-137	GS
Cobalt-60	GS
Curium-242	RT
Curium-244	RT
Europium-152	GS
Europium-154	GS
Europium-155	GS
Manganese-54	GS
Plutonium-238	RT
Plutonium-239	RT
Plutonium-240	RT
Rhodium-106	GS
Ruthenium-106	GS
Silver-108m	GS
Silver-110m	GS
Strontium-90	RT
Thorium-228	GS
Thorium-230	GS
Thorium-232	GS
Tritium-H ³	RT ^c
Uranium-232	RT
Uranium-234	GS/RT
Uranium-235	GS
Uranium-238	RT
Zinc-65	GS

a. Methods for determining the above listed radionuclides can be found in the standard operating procedures for the INEL Radiation Measurement Laboratory (see Table 3-13).

b. GS - to be determined by gamma spectrometric techniques.
RT - to be determined by radiochemical techniques and methods.

c. For aqueous samples only.

3.3 QUALITY ASSURANCE

Internal quality control (QC) checks are established by submitting QC samples to the analytical laboratory. The desired number of field quality control samples is at least 20% of the total number of field samples taken. The types and frequency of collection for field quality control samples are provided below:

- Trip blank--Trip blanks provide a measure of potential sample contamination due to the presence of contaminants in the reagent water source, to preservative contamination of the blank itself during blank preparation, to shipment of the prepared blank to the field, and/or to shipment from the field to the laboratory. The trip blank will be prepared using the lab's reagent water with the addition of all appropriate preservative chemicals. Trip blanks accompany the sample shipping container and will remain unopened until after the laboratory receives them for analysis.

Trip blanks will be collected at a minimum frequency of one per cooler when volatile organic samples are being collected and will be shipped blind to the laboratories with other samples and analyzed for volatile organics only. Trip blanks will be prepared to correspond to VOA bottles submitted for analysis.

- Decontamination (check) blank--A decontamination blank will be prepared and submitted for analysis at a minimum frequency of 1 per every 20 samples for each sample medium, as well as whenever there are changes in the sample collection procedures, sample decontamination procedures, sampling equipment, or sample collection personnel. This blank will consist of deionized rinse water collected after the water has rinsed decontaminated equipment and will be analyzed for the same parameters and similarly preserved as the sample group it checks.
- Field blank--Field blanks provide a measure of potential errors that can be introduced from sources other than the sample. A field blank will also measure input from contaminated dust or air into the sample. A field blank is prepared in the field by pouring deionized and/or reagent-grade (analyte-free) water into the appropriate sample containers and includes all appropriate preservative chemicals. Field blanks are prepared at a minimum frequency of 1 per 20 samples for each sample medium.
- Field replicates--Field replicates are collocated samples collected identically and consecutively over a minimum period. Field replicates provide a measure of the total analytical precision (field and laboratory variance), including precision resulting from the heterogeneity of the replicate sample set itself. Field replicates will be collected at a minimum frequency of 1 per 20 samples or 1 per sampling round for each sample medium.

The sampling and analysis plan tables (Appendix A) provide the anticipated number, type, and analysis of all samples including the field QA/QC samples. QA/QC samples that will be collected for the first sampling event in April 1992 are compiled in Table 3-5. The actual number and type of samples collected will be presented in the Characterization (RI) Report following the completion of the field activities.

3.4 ANALYTICAL PROCEDURES

EPA-published methods will be used as the basis for most nonradiological analyses. All nonradiological analytical and test methods to be followed are contained in Tables 3-6 through 3-11 and Table 3-14.

Table 3-6 references laboratory analytical protocols that will be used to determine chemical analytes of interest. Tables 3-7 and 3-8 provide references for determining physical, mineralogical, and geochemical properties as previously discussed. Table 3-9 lists the additional water quality analytes and associated analytical method. Tables 3-10, 3-11, and 3-14 provide target analyte lists for organics and inorganics.

Radiological constituents and associated analytical methods are presented in Tables 3-12 and 3-13. A detailed description of analysis methods and techniques, as well as QA/QC programs, can be found in documented and ERD-approved Radiation Measurements Laboratory (RML) standard operating procedures (SOPs) and the *EG&G Idaho Statement of Work for Radiological Analysis performed for the Environmental Restoration Department at the Idaho National Engineering Laboratory*, ERD-SOW-33, October 1991.

Table 3-13. INEL radiation measurements laboratory standard operating procedures

<u>Document Number</u>	<u>Title</u>
<u>Soil/Sediment Samples</u>	
RML-3 (Rev. 11/22/89)	RML Soil/Vegetation and Mammal Sample Measurements, Rev 01/19/90
DM-9 (Rev. 7/13/89)	Soil/Vegetation and Mammal Gamma Ray Analysis and Activity Report, July 1989
DM-1 (Rev. 4/19/89)	Evaluation and Verification of Data for Radionuclides Identification and Selection, April 1989
<u>Aqueous Samples</u>	
RML-6 (Rev. 11/22/89)	RML Liquid Sample Count/Analytical Procedures, November 1989
DM-11 (Rev. 7/13/89)	RML Gamma Ray Analysis and Activity Report of Lower Activity Level H ₂ O Samples, September 1989
DM-1 (Rev. 4/19/89)	Evaluation at and Verification of Data for Radionuclides Identification and Selection, April 1989
<u>Quality Assurance/Quality Control</u>	
QA/QC Program Plan of the RML for Gamma Spectroscopy and Direct Gas Alpha/Beta Counting (EG&G Idaho, 1989b)	

Table 3-14. SW-846 Method 8010 - target analyte list and quantitation limits

Compound	Retention time (min)		Method detection limit ^a (ug/L)
	Col. 1	Col. 2	
Benzyl chloride			
Bis(2-chloroethoxy)methane			
Bis(2-chloroisopropyl)ether			
Bromobenzene			
Bromodichloromethane	13.7	14.6	0.10
Bromoform	19.2	19.2	0.20
Bromomethane			
Carbon tetrachloride	13.0	14.4	0.12
Chloroacetaldehyde			
Chlorobenzene	24.2	18.8	0.25
Chloroethane	3.33	8.68	0.52
Chloroform	10.7	12.1	0.05
1-Chlorohexane			
2-Chloroethyl vinyl ether	18.0		0.13
Chloromethane	1.50	5.28	0.08
Chloromethylmethyl ether			
Chlorotoluene			
Dibromochloromethane	16.5	16.6	0.09
Dibromomethane			
1,2-Dichlorobenzene	34.9	23.5	0.15
1,3-Dichlorobenzene	34.0	22.4	0.32
1,4-Dichlorobenzene	35.4	22.3	0.24
Dichlorodifluoromethane			
1,1-Dichloroethane	9.30	12.6	0.07
1,2-Dichloroethane	11.4	15.4	0.03
1,1-Dichloroethylene	8.0	7.72	0.13
trans-1,2-Dichloroethylene	10.1	9.38	0.10
Dichloromethane			
i,2-Dichloropropane	14.9	16.6	0.04
trans-1,3-Dichloropropylene	15.2	16.6	0.34
1,1,2,2-Tetrachloroethane	21.6		0.03
1,1,1,2-Tetrachloroethane			
Tetrachloroethylene	21.7	15.0	0.03
1,1,1-Trichloroethane	12.6	13.1	0.03
1,1,2-Trichloroethane	16.5	18.1	0.02
Trichloroethylene	15.8	13.1	0.12
Trichlorofluoromethane	7.18		
Trichloropropane			
Vinyl chloride	2.67	5.28	0.18

^a Using purge-and-trap method (Method 5030).

4. SAMPLE IDENTIFICATION SYSTEM

4.1 SAMPLE IDENTIFICATION CODE

A systematic character sample identification code will be used to uniquely identify all samples. The uniqueness of the number is required for maintaining consistency and ensuring no two samples are assigned the same identification code.

The first two designators of the code, "1T", refers to the waste area group (WAG 1) and INEL site location (TAN). The third designator "Q" refers to the sample type or location. The next three numbers designate the sequential sample number for the project. A two character set (i.e., 01, 02, etc.) will be used next to designate replicate and triplicate samples. The last two characters refer to a particular analysis (and bottle type). Refer to Section 6 (Tables 6-1 and 6-2) for specific aliquot/bottle code designations.

For example, a groundwater sample collected from the aquifer might be designated as 1TQ00101DV where (from left to right):

- 1T designates the waste area group as TAN
- Q designates that it is an aquifer sample
- 001 designates the sequential sample number
- 01 designates type of sample (i.e., replicate)
- DV designates VOC analysis by method 524.2.

A sampling and analysis plan table/data base will be used to record all pertinent information (well designation, borehole number, depth, media, date, etc.) associated with each sample identification code. Sampling and analysis plan tables for the TAN RI/FS are presented in Appendix A of this FSP. The following section describes the table/data base.

4.2 SAMPLING AND ANALYSIS PLAN TABLE/DATA BASE

4.2.1 General

The sampling and analysis plan (SAP) table/data base format was developed to facilitate the reporting of SAP information to the data management group. The table is used as a planning tool for sample tracking, and as a data base when analyses are received. An abridged example of the SAP table for the TAN groundwater remedial investigation effort is shown in Table 4-1. The following sections describe the information found in the SAP table/data base.

4.2.2 Sample Description Fields

The sample description fields contain information relating individual sample characteristics.

Sample Number

The sample number is used to link information from other sources (field data, analytical data, etc.) to the information in the SAP table for data reporting, sample tracking, and completeness reporting. The sample number is also used by the analytical lab to track and report results of analysis. The size restriction of the sample number is attributable, in part, to the lab reporting requirement to identify QC samples by appending certain suffixes to the sample number.

Sample Type

Sample type is a four-character field. Data in this field will be the appropriate code from the following:

REG	for a regular sample
QC	for a quality control sample
OTHR	for other sample types not listed. Other types should be explained in the comments section of the table.

4-3

Form No: SAP17B

[illegible]

Media

Media is a 15-character field. Data in this field will be selected from the following:

SURFACE SOIL

SUBSURFACE SOIL

SEDIMENT

SURFACEWATER

GROUNDWATER

SOIL GAS

SLUDGE

WATER for other waters (e.g., rinsates, field blanks, trip blanks)

OTHR for other media types not listed; other types should be explained in the comments section of the table

Collection Type

Collection type is a four-character field. Data in this field will be the appropriate code from the following:

GRAB	for grab
COMP	for composite
SCMP	for spatial composite
CCMP	for continuous composite
DIC	for depth integrated composite
TCMP	for time composite
TBLK	for trip blanks
RNST	for equipment rinsates
FBLK	for field blanks

Sampling Method

Information in the sampling method field identifies a standard sampling method by number. If the sampling method is nonstandard, this field should reference the comment field where a brief explanation of the sampling method should be entered. This field is 15 characters wide.

Planned Date

Enter the date or an eight character event identifier relating to the planned collection of the sample (i.e., 08/24/89 or scoping investigation).

4.2.3 Sample Location Fields

This group of fields identifies the exact location for the sample in three-dimensional space, starting with the general AREA and narrowing the focus to an exact location geographically, then specifying the depth in the DEPTH field.

Area

The AREA field is a 15-character field that identifies the general sample collection area. This field should contain the standard identifier for the INEL area being sampled. For this investigation all samples are being collected in the TAN area. A short example list follows:

RWMC	Radioactive Waste Management Complex
TRA	Test Reactor Area
CFA	Central Facilities Area
TAN	Test Area North

Location

This is a 15-character descriptive field that may contain geographical coordinates, x-y coordinates, building numbers, or other location identifying details. It also contains program specific information such as a borehole or well number. Data in this field will normally be subordinated to the AREA. This information is included on the labels generated by data management to aid sampling personnel.

Type of Location

The type of location field is a 15-character field containing information descriptive of the exact sample location. Information in this field may

overlap that in the location field, but it is intended to add detail to the location.

Some examples of type of location information are influent, effluent, east pit, dry pond, well, pond, pit, lake, and disposal area.

Depth

The depth of a sample location is the distance in feet from surface level or a range in feet from the surface. The depth field is 10 characters wide.

4.2.4 Analysis Types

AT1-AT10, etc.

These fields are used to indicate analysis types (radiological, hydrological, etc.). Space is provided at the bottom of the form to clearly identify each type. A standard abbreviation should also be provided if possible.

A continuation sheet is used when the number of other analysis types exceeds the space on the table. It provides 34 more columns for identifying additional types of requested analysis. Each line on the continuation sheet corresponds to the same line of the original table and is linked by the sample number that is entered on each form.

5. SAMPLING EQUIPMENT AND PROCEDURES

5.1 DRILLING AND WELL CONSTRUCTION

5.1.1 Site Preparation

Prior to the drilling operation, the location will be staked and the area cleared of any obstructions. If necessary, the location of underground utilities will be determined by appropriate TAN facility personnel and geophysical surveys. All drill sites will also require archeological surveys.

5.1.2 Regional Aquifer

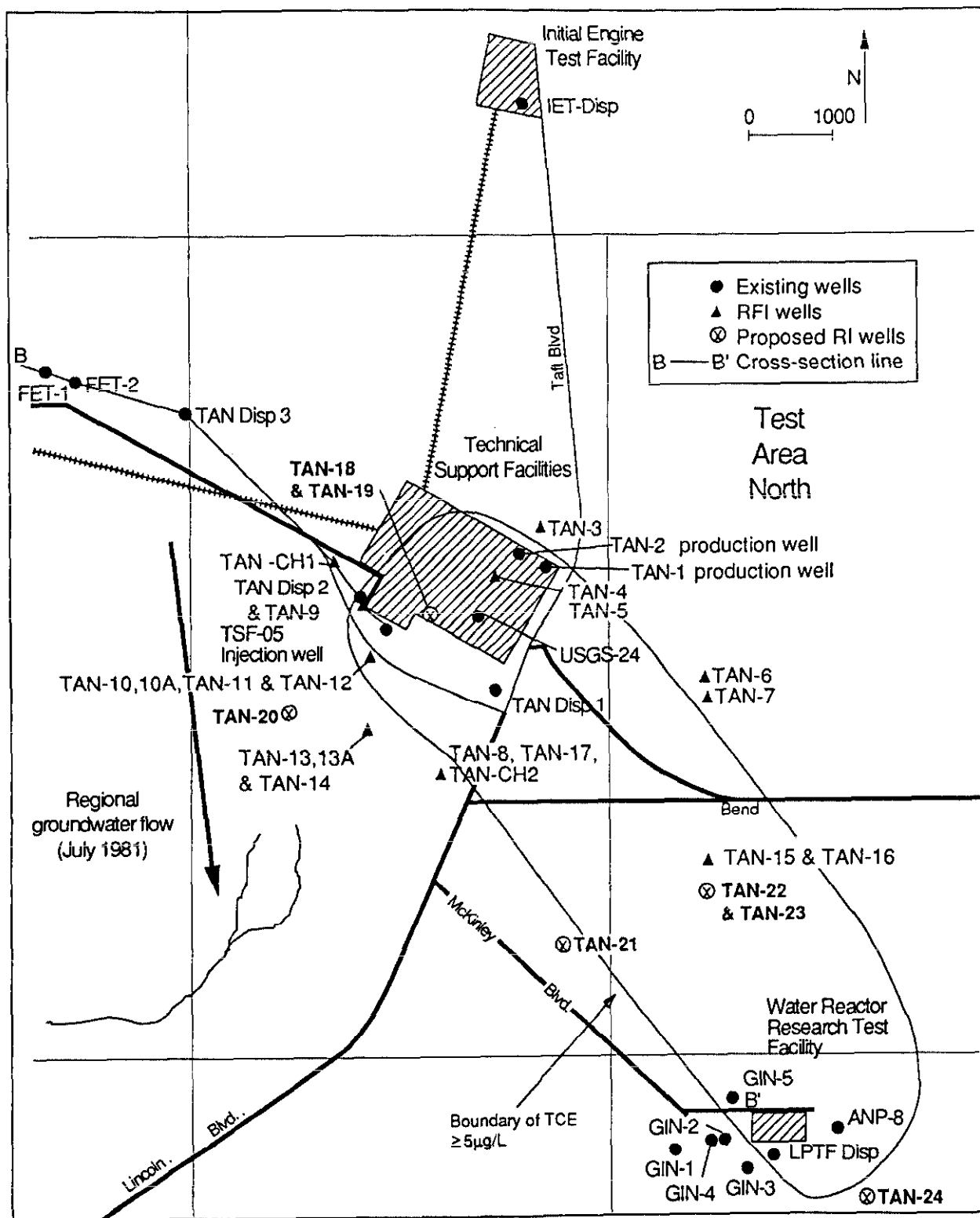
Seven aquifer wells, TAN-18 through TAN-24, will be drilled and completed in the regional groundwater aquifer. Four of the wells will be completed as cluster wells (i.e., TAN-18 and TAN-19; TAN-22 and TAN-23). TAN-20, TAN-21, and TAN-24 will be single completion well sites. The deep well of each cluster will be drilled and installed prior to drilling the shallow well of each cluster. The particular drilling methods used for the monitoring wells will depend upon the specific geologic conditions encountered at each well site. The following types of drilling may be used in descending order of preference: (a) reverse air rotary, (b) air rotary, (c) air rotary using foam, and (d) mud rotary. The disposition of drill cuttings is discussed in Section 5.4.

Drilling will be accomplished using air or water from approved and monitored sources, unless the use of additives is necessary. The use of drilling additives must receive prior approval from the Project Manager. Compressed air from the air compressor will be filtered to eliminate the possibility of introducing contaminants into the subsurface environment through the injection of compressed air containing oils. The only water to enter the borehole will be taken from the LOFT production wells (or other potable sources) located west of TSF. These wells are located upgradient from the TSF-05 injection well and are free of contaminants based on existing water quality data. The drill rig and all ancillary equipment will be decontaminated as discussed in Field Sampling Method (FSM) #8. Pipe joint

compounds containing petroleum products shall not be used because of the potential for contamination. Molybdenum-based joint compounds (i.e., Molykote) may be used to lubricate the pipe joints provided they do not contain petroleum-based products. To reduce the amount of dust generated during the drilling operation, a controlled amount of water can be injected. The amount of water should be adjusted so the resultant air is moist and not producing water at the surface.

Well locations were determined during scoping meetings between the DOE, the EPA and the State of Idaho and from an evaluation of existing hydrogeologic data. TAN-18 and TAN-19 will be drilled and constructed at a location between the TSF-05 injection well and the USGS-24 well. Well TAN-20 will be installed west of existing monitoring well TAN-13A (southwest of the TSF-05 injection well). TAN-21 will be completed approximately midway between the TSF-05 injection well and the GIN wells at WRRTF along the anticipated southern boundary of the contaminant plume. The TAN-22 and TAN-23 well cluster will be drilled and installed adjacent to and down-gradient from existing monitoring wells TAN-15 and TAN-16, which are located approximately 3/4 to 1-mi down-gradient from the TSF-05 injection well. TAN-24 will be installed down-gradient from the WRRTF production well ANP-8. Well locations are shown in Figure 5-1.

The total drilling depth for each of the boreholes, as well as monitor well completion depths, will be determined from both hydrogeologic information and the results of water quality analysis. The overall objectives/criteria for determining well completion depths are (a) to locate and provide groundwater monitor points at the leading (vertical) edge of the TCE plume (i.e., $\geq 5\mu\text{g/L}$), (b) to provide groundwater monitoring points below the leading edge of the plume (i.e., $< 5\mu\text{g/L}$) to detect future TCE migration, and (c) to provide groundwater monitoring points at the southwestern, southern, and southeastern lateral extent of contamination. The current hypothesis is that the Q-R interbed is laterally continuous and represents a confining layer to the movement and distribution of contaminants. Therefore, in addition to the above objectives, the drilling program will attempt to determine the continuity and nature of the Q-R interbed and its effects on contaminant migration. The contaminant plume for this investigation is defined as TCE at a level greater than or equal to the safe drinking water MCL of $5\mu\text{g/L}$.



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Figure 5-1. Existing and proposed well locations.

Based on the above discussion, the deep borehole of each well cluster (TAN-19 and TAN-23) will be drilled first. It is anticipated that these wells will be completed in the first permeable zone below the Q-R interbed and that this depth will correspond to TCE concentrations $< 5\mu\text{g/L}$. The shallow wells of each cluster (TAN-18 and TAN-22) and the single completion well sites (TAN-20, TAN-21, and TAN-24) will be drilled to the top of the Q-R interbed. These wells will be completed in the last (deepest) zone where TCE is detected at concentrations $\geq 5\mu\text{g/L}$. It is anticipated that this depth will be at or above the Q-R interbed. In the event that the Q-R interbed is determined not to be continuous and/or TCE concentrations are $\geq 5\mu\text{g/L}$ below the Q-R interbed, drilling, groundwater sampling, and hydrologic testing will continue to a depth where the groundwater TCE concentration is below the MCL of $5\mu\text{g/L}$. However, if TCE $\geq 5\mu\text{g/L}$ persists below approximately 550 ft bls the need for additional wells to provide an accurate vertical profile of contamination will be evaluated.

To achieve these objectives, the drilling program must be flexible enough to respond to changing subsurface conditions. In general, the boreholes will be drilled and monitor wells installed, as discussed below.

For each well, a nominal 17½-in.-diameter borehole will be drilled from land surface to a depth 5 ft into competent basalt (55 to 60 ft) and 14-in. outside diameter steel surface casing will be installed. The annulus between the casing and the borehole will be grouted using a cement mixture consisting of Type I or II cement, 7 to 9 gal of water per bag of cement, and approximately 5% by weight bentonite hydrated per manufacturer's instructions. The grout will be allowed to cure a minimum of 12 hours before drilling continues.

TAN-19 and TAN-23

A nominal 8¾-in. borehole will be drilled to the top of the P-Q interbed (see Table 5-1). The interbed will be sampled/cored as described in Section 5.1.3.

After interbed sampling, the 8¾-in. borehole will be advanced to the first aquifer testing and groundwater sampling point. This depth will be the

first permeable zone encountered after the borehole has been advanced at least 30 ft deeper than the completion depth of the nearest already existing well. Aquifer testing and groundwater sampling will be repeated at permeable/fracture zones down to the Q-R interbed as well as on top of the Q-R (see Section 5.1.4 for detailed discussion of aquifer testing and groundwater sampling during drilling). The Q-R interbed will be sampled (see Section 5.1.3) and then the 8 3/4 -in. borehole will be advanced to the first permeable zone below the interbed where aquifer testing and groundwater sampling will be repeated. If groundwater sample analyses (and confirmation sample) indicate that the groundwater is below the action limit of 5µg/L, drilling will be stopped, geophysical and video logs will be run, and the wells will be constructed.

TAN-18 and TAN-22

A nominal 8 3/4 -in. borehole will be drilled to the designated aquifer testing and groundwater sampling depth (see Table 5-1). This depth will be based on the last (deepest) zone in the adjacent deep borehole where TCE was detected at or above 5µg/L. Aquifer testing and groundwater sample will be carried out as described in Section 5.1.4. TAN-18 and TAN-22 will be completed in the deepest zone where TCE concentrations are $\geq 5\mu\text{g/L}$. It is anticipated that this depth will be at or above the Q-R interbed.

Once total drilling depth has been determined, a down-hole television video log and geophysical borehole logging will be conducted to confirm appropriate completion intervals. Geophysical logs will include caliper, natural gamma, neutron epithermal neutron, and gamma-gamma (see Appendix B-FSP, Field Sampling Methods).

TAN-20, TAN-21 and TAN-24

A nominal 8 3/4 -in. borehole will be advanced to the first aquifer testing and sampling point. For TAN-20 and TAN-24 this depth will be the first permeable zone encountered after the borehole has been advanced at least 30 ft deeper than the completion depth of the nearest already existing well (see Table 5-1). For TAN-21 this depth will be the first permeable zone below the water table since no nearby wells exist for well control. Aquifer testing

Table 5-1. Approximate depths of the P-Q and Q-R interbeds, aquifer testing and groundwater sampling depths, and completion depths for the monitoring wells

Well	P-Q Interbed (ft bls)	Q-R Interbed (ft bls)	Initial Aquifer Testing and Sampling Depths (ft bls)	Additional Aquifer Testing and Sampling Depths (ft bls)	Completion Depth of Nearest Existing well (ft bls)	Approximate Completion Depth (ft bls)
TAN-18	200	415	415	NA	TSF-05 269-305	395-415
TAN-19 (deep)	200	415	340	380, 415, 450	TSF-05 269-305	430-450
TAN-20	195	415	415	NA	TAN-12 362-382	395-415
TAN-21	260	450	240	290, 340, 390, 450	NA NA	430-450
TAN-22	260	450	450	NA	TAN-16 302-322	430-450
TAN-23 (deep)	260	450	355	400, 450, 480	TAN-16 302-322	460-480
TAN-24	330	520	325	375, 425, 475, 520	ANP-8 302	500-520

and groundwater sampling will be repeated at permeable/fracture zones down to the Q-R interbed. Completion depths for all three boreholes will be in the last (deepest) zone where TCE is detected $\geq 5\mu\text{g/L}$. It is anticipated that this depth will be at or above the Q-R interbed.

The wells will be completed using 20 ft of 4-in. inside diameter (ID), type 304, stainless steel well screen (0.020-in. slot size) attached to 4-in. ID, type 304, schedule 5 stainless steel well casing. All well casing will be flush-threaded according to ASTM F480-88A. In addition, all casing and screen will be steam cleaned and bagged by the manufacturer prior to shipment. The bottom of the well screen will be fitted with a stainless steel end cap. Stainless steel centralizers will be used to help keep the casing and screen centered in the borehole. The wells will be installed to a depth of no more than 3 ft from the bottom of the borehole. If the borehole has been over-drilled and is more than 3 ft deeper than the bottom of the deep completion interval, a bentonite plug will be installed to bring the bottom of the borehole to within the 3-ft minimum.

Once the casing and screen are in place, a granular filter pack will be installed through a tremie pipe to approximately 5 ft above the top of the well screen. The filter pack will consist of bagged quartz sand (size 6 to 8). Above the sand pack, commercially available pelletized bentonite will be installed through a tremie pipe and will extend at least 5 ft above the top of the filter pack. The bentonite shall have a dry bulk density of at least 80 lb/ft^3 . A minimum of four hours will be allowed for the bentonite to hydrate prior to the grouting operation.

The annular space from the top of the bentonite seal to 4 ft below land surface will be grouted using a cement grout containing a ASTM Type I or II cement, 5% bentonite, and either pea gravel or sand to help bridge and seal fractures in the basalt. The grouting operation will be limited to a maximum of 150 ft lifts with a minimum four hour wait between lifts. The installation of all well completion materials (filter pack, bentonite, and grout) will be done using a tremie pipe.

The placement of all well construction materials will be recorded by the onsite geologist to the nearest 0.5 ft. Measurements will be taken using

either a weighted tape measure or the tremie pipe. A schematic well completion diagram is presented in Figure 5-2.

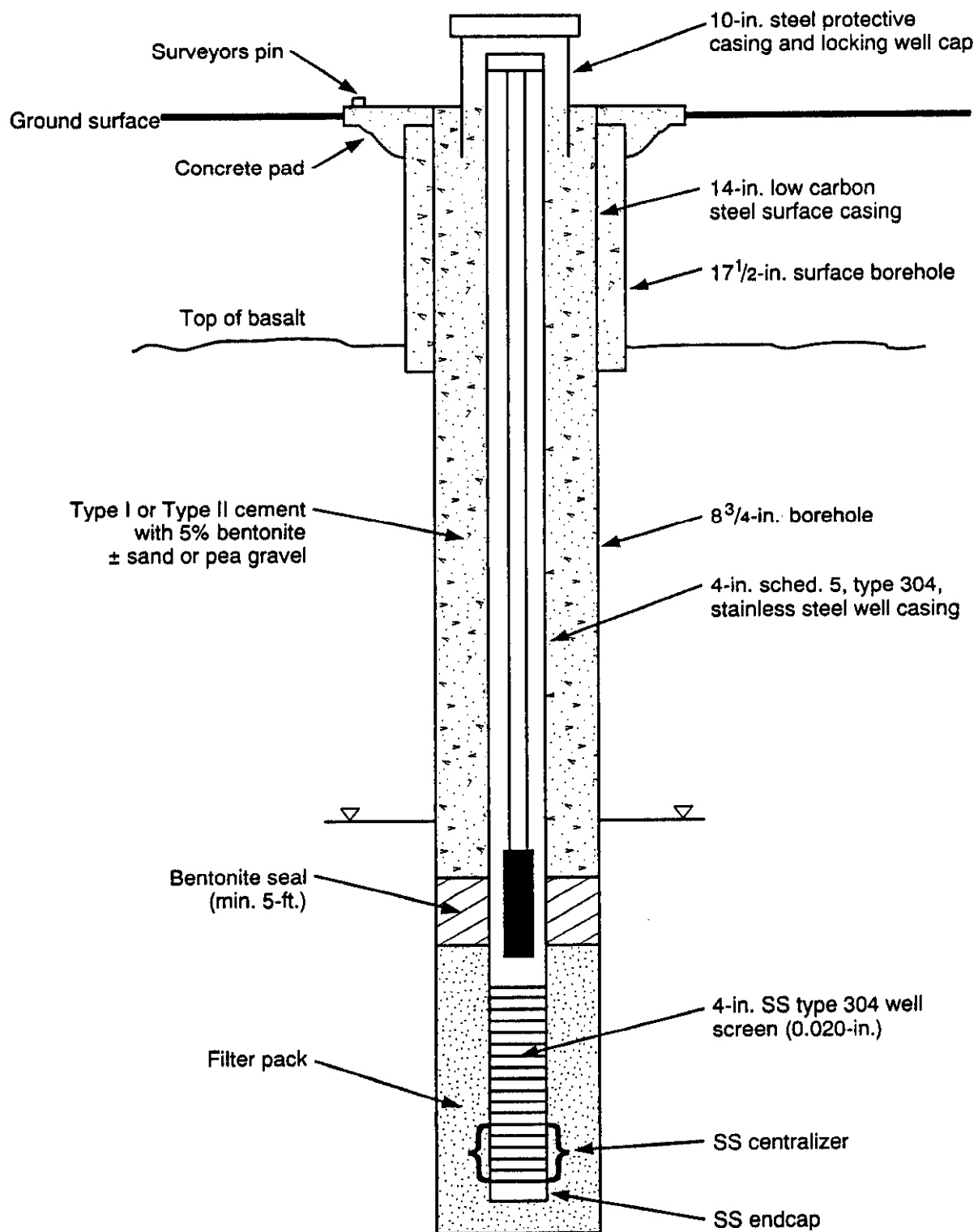
5.1.3 Interbed Sampling

Lithologic samples will be collected from the P-Q and Q-R interbeds (see Figures 1-5 and 1-6 and Table 5-1) from the deep boreholes of the two well clusters to determine the hydrologic, mineralogic, and geochemical properties. A minimum of 3 ft of each interbed will be sampled. Near the top of the interbed, the drill steel will be removed from the borehole and sampling equipment installed. Multiple sampling methods will be used to collect the samples. The depth to the top of the sample interval will be measured to 0.5 ft.

After the sampling device (i.e. core barrel, shelby tube, pitcher sampler, etc.) has been advanced into the interbed, the sample will be withdrawn from the borehole. The ends of the sample tube will be measured for direct radiation and organic vapors and results will be logged. The sample will be taken to the work station for sample preparation. Both ends of the tube will be capped, taped, and the tube appropriately labeled (e.g., top & bottom). A label will be placed on the sample tube describing the sample location, depth, date, and any important physical descriptions. The sample will be ready for transport to the contracted laboratory for analyses (see Tables 3-7 and 3-8).

5.1.4 Aquifer Testing and Groundwater Sampling During Drilling

To accurately define or identify vertical extent of TCE contamination and to obtain information on the aquifer characteristics, an aquifer testing and groundwater sampling program will be conducted during the drilling process (aquifer parameters calculated for TAN are shown in Table 2-4 of this FSP). Testing and sampling in the TAN-19, TAN-20, TAN-23, and TAN-24 boreholes will commence at the first permeable zone encountered at a depth below the completion interval of the nearest existing well. Testing and sampling for TAN-21 will commence at the first permeable zone below the water table. Aquifer testing and sampling in the TAN-18 and TAN-22 boreholes will be carried out at depths corresponding to the last (deepest) zone where TCE was



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Figure 5-2. Schematic well completion diagram.

detected at concentrations $\geq 5\mu\text{g/L}$ in the adjacent deep boreholes (TAN-19 and TAN-23). Aquifer testing and groundwater sampling will be repeated at selected permeable zones over the entire depth of the borehole. Aquifer testing and groundwater sampling will also be carried out at the top of the Q-R interbed in all boreholes and below the Q-R interbed in boreholes TAN-19 and TAN-23. Permeable zones refer to basalt flow tops and bottoms or fracture intervals, and are recognized during drilling as a result of lost circulation or extensive borehole caving. In the event that the geologist and drilling subcontractor cannot determine the extent or nature of a potential permeable zone, geophysical logs will be run by the USGS on the borehole. A discussion of this program is provided below.

The boreholes will be advanced to a point just below a permeable zone. A straddle-packer assembly and submersible pump will be inserted into the borehole and the zone in question packed off. The packer will be inflated at the bottom of the lowest competent basalt identified above the permeable interval selected for testing and sampling. The test zone (from the bottom of the packer to the bottom of the borehole) will be allowed to stabilize and then the aquifer test will be started. During testing the groundwater will be monitored until the pH, temperature, and specific conductance stabilize. A triplicate groundwater sample will then be collected for analysis of VOCs by SW-846 method 8010 (see Table 3-14). An onsite mobile analytical laboratory will be used for sample analysis. Transducers will be connected to the packer assembly to monitor hydraulic head both above and below the packer during the draw down and recovery phases of the test. If the well yields more than 10 gpm, well discharge measurements will be taken using either an in-line flow meter or manometer. If the sampled zone yields less than 10 gpm, well discharge will be determined by pumping the discharge into a container of known volume (usually a 5-gal bucket). A stopwatch will be used to measure the amount of time necessary to fill the container. The equations used to analyze the data will depend on the character of the draw down and recovery curves, as well as geologic information obtained during drilling. However, it is anticipated that the Theis (1935) and Cooper and Jacob (1946) methods will be used to analyze data from confined portions of the aquifer, and the Neuman (1975) technique will be used to analyze data from unconfined portions of the aquifer.

Groundwater samples will be analyzed using SW-846 8010 within approximately 12 hours of collection using the onsite mobile laboratory. The borehole will not be advanced until the results of triplicate analyses are available. If TCE is detected at or above 5 $\mu\text{g/L}$ for even one of the triplicate samples, the borehole will be advanced to the next selected permeable zone and the tests repeated. If TCE is detected below the action limit of 5 $\mu\text{g/L}$, a second triplicate groundwater sample from the same zone will be collected and analyzed for confirmation. If all confirmation samples show TCE < 5 $\mu\text{g/L}$, drilling will stop and the wells will be installed in the appropriate zone as discussed in Section 5.1.2 and below. TAN-19 and TAN-23 will be installed in the permeable zone where TCE is < 5 $\mu\text{g/L}$. Completion depths for wells TAN-18, TAN-20, TAN-21, TAN-22, and TAN-24 will correspond to the last (deepest) zone where the triplicate groundwater sample detected TCE \geq 5 $\mu\text{g/L}$.

5.1.5 Slug Testing

All installed characterization wells will be hydraulically tested using either standard or pneumatic slug testing methods. Slug-test data will verify that the characterization wells are in good hydraulic communication with the Snake River Plain Aquifer. Testing with the pneumatic slug technique involves depressing the water level in the well using compressed air. The induced water level is then permitted to stabilize, the air pressure is released rapidly, and the water level is allowed to rise within the wellbore. The rise in water level is recorded using a pressure transducer and data logger, and is matched to type-curves to determine the transmissivity of the well. Wells will be instrumented with pressure transducers to record the change in water level. A hydrogeologist will oversee the testing and analyze the results to determine well parameters. Once the monitoring wells are completed, selected wells will have continuous water-level recorders installed to measure fluctuations in the water-level and provide information about the hydraulic connection among the wells. Well selection for recorder installation will be based on the locations of monitoring wells with respect to potential pumping well influences, as well as on subsurface geologic information.

Water levels will be measured in the Snake River Plain Aquifer monitoring and observation wells in the vicinity of TAN on a monthly basis. For wells

within a 1/2-mi radius of the TSF, WRRTF, and LOFT/SMC facilities, water levels will be measured only after the specific facilities production well(s) have not been pumping for a minimum of four hours. This requirement will negate the effects of production well pumping on water levels at TAN.

5.2 WELL COMPLETION

5.2.1 Well Straightness and Plumbness

A drift indicator, inclinometer, or other technique that is standard to the industry will be used to determine straightness and plumbness for each installed well. To help ensure straightness and plumbness during well installation, the casing and screen will be hung until well completion materials are installed and the grout has been allowed to set up for 12 hrs.

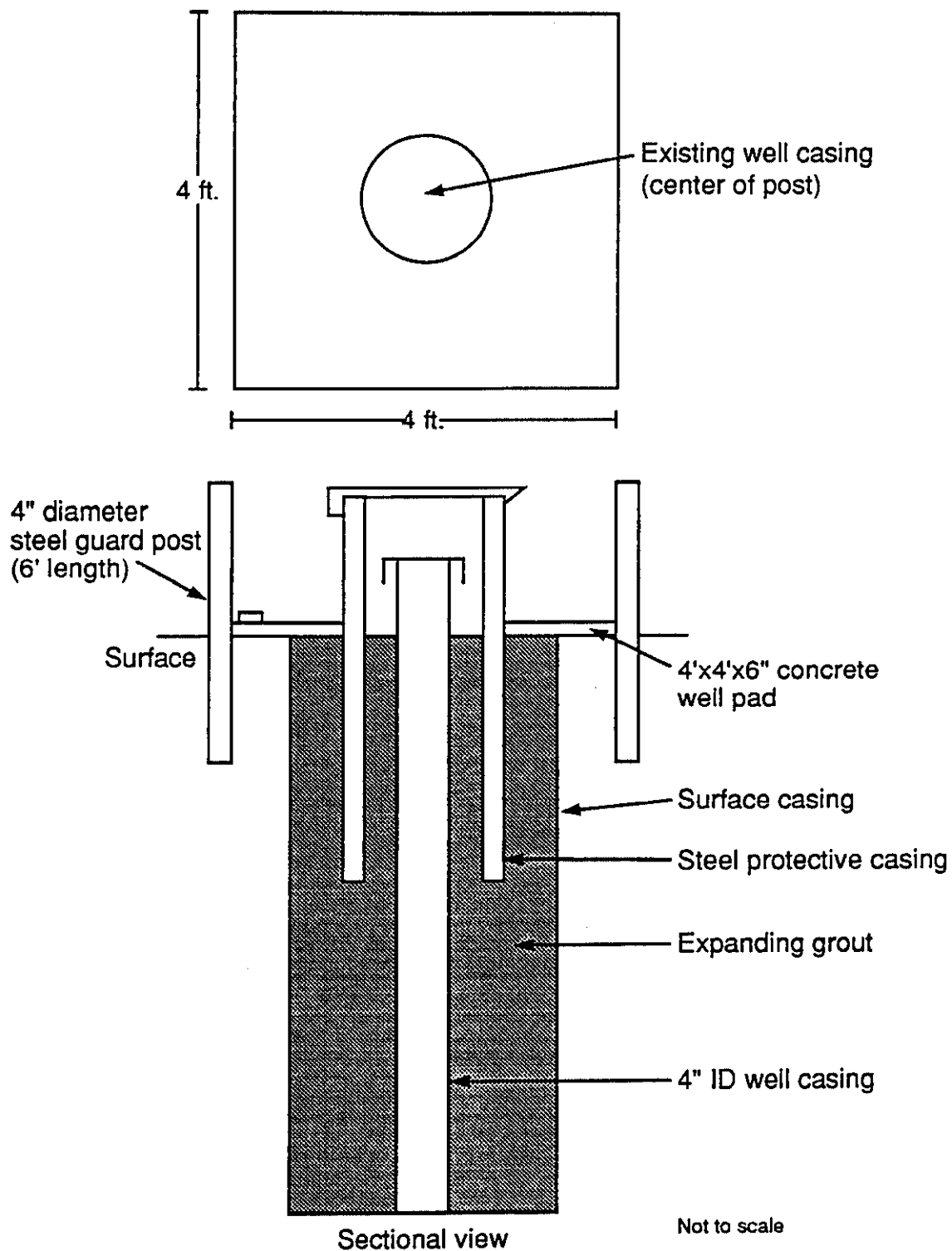
5.2.2 Surface Completion

Completion of each well will include the installation of a 4-ft by 4-ft by 6-in. thick reinforced concrete surface pad as shown in Figure 5-3.

Construction of the concrete pad is described as follows:

- **Formwork:** Forms will be tight to prevent leakage of concrete. Bracing will be used as necessary to maintain the desired position and alignment during and after concrete placement. Forms will be removed 24 hours (approximately) after the pour. No hand mixing of concrete will be allowed. A 3-in. diameter brass survey marker will be placed in the concrete pad.
- **Excavation:** The existing ground surface will be excavated to provide a minimum 2-in. inset of concrete pad into the existing native soil. The surface of the pad will extend a minimum of 2 in. above the existing ground surface.

Protective steel casing constructed from a 6-ft length of 10-in. inside diameter steel casing will be installed with 4-ft of casing below the land surface. Locking steel protective caps, provided by the Operating Contractor, will be installed on the new TAN groundwater monitoring wells.



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Figure 5-3. Construction diagram of surface completion for wells.

Three guard posts will be installed around the perimeter of each well. Each guard post will consist of a 6-ft length of 4-in. diameter carbon steel, schedule 40 pipe. The guard post will extend a minimum of 3 ft above the land surface and will be emplaced in a 12-in. diameter 3-ft deep hole. The hole and the inside of the steel pipe will be completely filled with concrete. One of the posts will be made removable by using a 5-in. sleeve grouted in place.

5.2.3 Well Development

The wells will be developed by mechanically surging using a surge block that is plunged up and down in the casing, similar to a piston in a cylinder. The surge block will be lowered into the well until it is below the static water level. The initial surging motion shall be gentle, allowing any material blocking the screen to break up, go into suspension, and then move into the well. The weight on the block is provided by the drill pipe. The speed of retraction and length of pull are governed by the physical characteristics of the drill rig.

After surging for at least 10 minutes and to the satisfaction of the onsite field representative, the block will be pulled from the well, and a submersible pump will be installed. Each well will be pumped until the water obtained is visibly free of turbidity and produces three consecutive samples for which the deviation of pH, temperature, specific conductance, and color meet the following criteria:

pH: ± 0.1 standard units
temperature: $\pm 0.5^{\circ}\text{C}$
specific conductance: ± 10 mmhos/cm
color: no visually discernible difference

All well development water removed from the wellbore will be containerized pending treatment and the results of chemical and radiological analysis (see Section 5.4 and the Waste Management Plan Addendum).

5.2.4 Wellhead Survey

Monitoring well locations will be surveyed only after the final protective surface casings and locking caps are installed. A second-order horizontal and vertical survey will be conducted. Three elevations will be measured:

- Top of the inner well casing (to the mark on the lip)
- Top of the outer protective well casing
- Brass cap in the concrete pad adjacent to the outer well casing.

A second-order survey is being initiated for all wells on the INEL site. Both existing and newly installed RI wells will be surveyed during this program.

5.2.5 End of Well Report

End of Well (EOW) reports will be completed after the RI wells have been installed, developed, and surveyed. EOW reports will follow the format outlined in EG&G Idaho ERD Program Directive 3.6. This includes placing an "as built" construction diagram of each well in an Engineering Design File per EG&G Idaho ERD PD 4.3. The EOW reports will be included as an appendix to the RI Report.

5.3 GROUNDWATER MONITORING AND SAMPLING

5.3.1 Field Measurements

5.3.1.1 Water Level Measurement. Water levels will be measured in the Snake River Plain Aquifer monitoring and observation wells in the vicinity of TAN on a monthly basis. The water-level data will be used to determine hydraulic gradients, and the direction of groundwater flow.

The measurements will be made using either an electronic measuring device (FSM #1) or a steel tape measure (FSM #2). For wells within a 1/2-mi radius

of the TSF, WRRTF, and LOFT/SMC facilities, water levels will be measured only after the specific facilities production well(s) have not been pumping for a minimum of four hours. This requirement will negate the effects of production well pumping on water levels at TAN.

Selected well pairs both within and outside the area of pumping influence from the TAN production wells (TAN-1 and TAN-2) will be instrumented with pressure transducers/Stevens recorders (continuous measurement) to record changes in water levels as a result of production well pumping. Field procedures for measuring water levels are included in FSM's #1 and 2 (Appendix B). The water levels will be measured from the surveyed reference marker and recorded to the nearest 0.01 ft. The instruments will be decontaminated in accordance with FSM #8 (Appendix B).

5.3.1.2 Temperature, pH, Specific Conductance, Dissolved Oxygen and Total Dissolved Solids. Temperature, pH, specific conductance, and dissolved oxygen will be monitored during well development and each sampling event by a Hydrolab (Surveyor II or Scout II) or equivalent. Total dissolved solid measurements will also be taken at this time. Regular readings will be taken and recorded in the field notes. A detailed field procedure for the Surveyor II is included in Appendix B (FSM #7). The factory provided Scout Operating Manual and Performance Manual for the Hydrolab Scout will be used, Hydrolab Corporation, March 1988.

5.3.2 Well Purging

All wells will be purged prior to sample collection. A minimum of three well casing volumes of water will be removed. If the well is pumped dry, samples will be collected as soon as there is enough water to fill the required sample bottles. Wells purged with a pump will be purged at a flow rate less than 20 gpm.

Wells TAN-18 through TAN-24 will be purged using temporary submersible pumps. USGS wells, RFI wells, and other existing production and observation wells will be purged using either dedicated or temporary pumps. The discharge volume will be recorded, and all purge water will be containerized, treated, and disposed as discussed in the Waste Management Plan (an addendum to this

Work Plan). For wells where historical data have not shown the presence of contaminants, purge water will be screened using field instruments. If field screening does not detect the presence of contaminants, the purge water from these wells will be discharged to the ground. The only wells for which purge water discharge to the ground is planned are the outlier wells USGS-26 and ANP-9.

During the purging operation, the Hydrolab (FSM #7) will measure specific conductance, pH, dissolved oxygen, and temperature initially and at least once during every well casing volume removed. Total dissolved solids will also be measured. Appendix E of the Work Plan provides construction details for calculating purge volumes for the existing aquifer wells that will be sampled. Well purging procedures are provided in FSMs #4 and 5. When three consecutive Hydrolab readings are within the limits listed below, a sample for water quality analysis can be collected.

pH: ± 0.1 standard units
temperature: $\pm 0.5^{\circ}\text{C}$
specific conductance: ± 10 mmhos/cm
color: no visually discernible difference

5.3.3 Groundwater Sampling Procedures

Prior to sampling, all sampling equipment that comes in contact with the water sample will be cleaned following FSM #8 for decontaminating sampling equipment (see Appendix B). The exception to this will be dedicated submersible sampling pumps, and discharge pipes that cannot be removed from the well. Prior to sample collection, the water level in the well will be measured (FSM #1 and 2) and the well will be purged, as described in Section 5.3.2.

If the parameters do not stabilize after three well casing volumes have been removed, purging will continue. If parameters are still not stable after five volumes have been removed, samples will be collected and appropriate notations will be recorded in the logbook.

Two groundwater sampling events are planned as part of RI/FS activities. Groundwater samples will be collected from a network of 30 to 37 monitoring, observation, and production wells in both April and October 1992. Existing wells (30) in the network are listed in Table 3-4. The seven wells installed as part of the RI will also be sampled after installation. Samples will be collected from each well and submitted for analysis of volatile organics, metals, radionuclides, alkalinity, and inorganics (fluoride, sulfate, chloride, and nitrate/nitrite). Table 6-1 outlines the generic requirements for containers, preservation methods, sample volumes, and holding times for the various analyses listed above for the aqueous samples. Sample bottles for liquid inorganic analyses will be filled to approximately 90-95% of capacity to allow for content expansion or preservation. Sample bottles for radionuclide analyses shall be filled as full as possible, leaving only enough room for preservative. The 40-ml glass VOA vials will be filled completely with absolutely no headspace or air bubbles. HCL preservative will be introduced into the VOA vials prior to sample collection and tested for pH < 2 after sample collection. One 500-ml sample will be collected for analysis of nitrate/nitrite and preserved with concentrated sulfuric acid (H_2SO_4) to a pH < 2. One 500-ml sample will be collected for sulfate and chloride analysis, and one 250-ml sample will be collected for alkalinity analysis. One 1-liter sample will be collected for fluoride analysis. The above three samples do not require preservation other than cooling to 4°C. One 1-liter sample will be collected for metals analysis and will be acidified to a pH < 2 using 10% ultrapure nitric acid (certified metals free). Groundwater samples will be collected for radiological analyses, including gross alpha/beta, gamma spectroscopy (screen), Sr-90, and tritium. One 540-ml sample, acidified with HNO_3 to pH < 2, will be collected for gross gamma analysis. A 125-ml sample will be collected and preserved with HNO_3 to pH < 2 for gross alpha/beta. One 1-liter sample will be collected for analysis of Sr-90 and will be preserved with HNO_3 to a pH < 2. One 125-ml sample will be collected for tritium analysis. The preferred order for sample collection is as follows:

- temperature, pH, specific conductance, dissolved oxygen and total dissolved solids (during purging)
- volatile organics (collected at flow rates < 5 gpm)
- total metals

- inorganics (sulfate, chloride, fluoride, nitrate/nitrite)
- alkalinity
- radionuclides (Sr-90, tritium, gross alpha/beta and gamma).

5.4 HANDLING AND DISPOSITION OF INVESTIGATION-DERIVED WASTE

Wastes derived from remedial investigation activities may include drill cuttings from borehole drilling, well development/drill water, purge water generated during sampling activities, and sludge from the sampling activities on the TSF-05 injection well. The procedures and requirements for handling and disposing of these investigation-derived wastes are discussed in detail in the Waste Management Plan (an Addendum to this Work Plan).

6. DOCUMENT MANAGEMENT AND SAMPLE CONTROL

Section 6.1 summarizes document management and sample control. Documentation includes all field documents used to record field data and document sampling procedures. Sampling documents include chain of custody forms and sample container labels. Section 6.2 outlines the sample containers and preservatives that will be used and discusses chain of custody, radioactivity screening, and sample packaging for shipment to the analytical laboratories.

6.1 DOCUMENTATION

The Field Team Leader is responsible for controlling and maintaining all field documents and records, and for ensuring that all required documents are submitted to ERD Administrative Records and Document Control (ARDC). All entries will be made in permanent ink. All errors will be corrected by drawing a single line through the error and entering the correct information. All corrections will be initialed and dated. The serial or ID number and disposition of all controlled documents (e.g., chain of custody forms) will be recorded in the document control logbook. If any documents are lost, a new document will be completed. The loss of a document and an explanation of how the loss was rectified will be recorded in the document control logbook. The serial number and disposition of all damaged or destroyed field documents will also be recorded. All voided and completed documents will be maintained with ARDC.

6.1.1 Sample Container Labels

Waterproof, gummed labels containing preprinted information concerning the sample ID number, the name of the project, sample location, and the analysis type will be used instead of the I-Chem container labels included with the sample containers. In the field, labels will be completed and placed on the containers before collecting the sample. Information concerning sample date, time, preservation used, field measurements of hazards, and the sampler's initials will be filled out during field sampling. Figure 6-1 shows an example of a sample container label.

SAMPLE DESCRIPTION: _____	REMARKS: _____ _____ _____ _____
LOCATION: _____	
DATE: _____	
TIME: _____	
MEDIA: _____	
SAMPLE TYPE: _____ PRESERVATIVE: _____	
ANALYSIS: _____	
SAMPLED BY: _____	
SAMPLE ID NO.: _____	

Z91 0083

Figure 6-1. Sample container label.

Preprinted labels will not have a serialized number. The preprinted sample ID number will serve as a unique label identifier. Labels will be distributed daily and remain in the custody of the Field Team Leader when not in use.

6.1.2 Field Guide Forms

Field guide forms are used to facilitate sample container documentation and organization of field activities. Field guide forms contain information on the sample request number, sample ID numbers, sample location, aliquot ID, analysis type, container size and type, and sample preservation. An example of a field guide form is shown in Figure 6-2.

6.1.3 Field Logbooks

Field logbooks, in accordance with ARDC format, will be used to record information necessary to interpret the analytical data. All field information pertaining to the sampling team activities will be entered in the logbooks. Entries will be dated and signed by the individual making the entry. All logbooks will be QC checked daily for accuracy and completeness by the Field Team Leader or an appointed designee. The person responsible for QC checks will sign his or her name in the appropriate space, indicating the above information is true and correct. All field logbooks will be controlled and managed according to EG&G Idaho ERD PD 4.2.

6.1.3.1 Sample Logbooks. Sample logbooks will be used by the field teams. Each sample logbook will contain copies of forms to record specific sample collection information. Appendix C contains examples of the sheets contained in this book. All QC samples (trip blanks, field blanks, and equipment decontamination rinsate blanks) will be recorded in the sample logbook. Groundwater samples will also be recorded here.

6.1.3.2 Drilling Logbook. The well drilling, installation, and development logbook will be used to record the drilling and development activities for monitoring/characterization wells. The logbook will contain a unified soil classification sheet, a monitoring well installation log, a

ENVIRONMENTAL PROBLEM NUMBER:
 Sampling Team:
 Account Code: TAN
 Sample Request: 1T001
 Sample Number(s): 1TQ001 through 1TQ003
 Media: Water
 Sample Type: Grab
 Sampling Method: FSM 4
 Suspected Sampling Hazard: Organics
 Sample Location(s): TAN OU1-07, Location 01, TAN-12
 ANALYSES VOA-524.2, Metals - CLP
 RAD: Gamma Spectroscopy, Radiochemistry
 NON-RAD: 524.2 Organics, CLP Inorganics,
 FIELD: Rad, Organic Vapors
 Sample Containers, Volumes, and Preservatives:

<u>Aliquot ID</u> <u>(10th char.)</u>	<u>Analytical</u> <u>Parameter</u>	<u>Container Volume</u> <u>or Type</u>	<u>Preservative</u>
2	VOA	40 ml vial	4°C/HCL
1	CLP Inorganics	1000 ml WM glass	4°C/HNO ₃
3	Gamma Spec/Radiochem	16 oz plastic squat	None

Figure 6-2. Example of a sample field guide form.

legend field log of drill hole, and a well development data form. Appendix C provides examples of this logbook. End of Well Reports with as built diagrams will be developed per EG&G Idaho ERD PD 3.6. As built well construction diagrams will be placed in an Engineering Design File per EG&G Idaho ERD PD 4.3 and will also be included in the RI report.

6.1.3.3 Sample and Core Description Logbook. Sample and core description logbooks will be used to record each sample of core collected. This logbook will contain logsheets to record a description of the core and its measurements. This logbook will also contain logsheets to record specific sample location information. Appendix C contains examples of the sample and core description logbook.

6.1.3.4 Field Team Leader's Daily Logbook. A project logbook will be maintained by the Field Team Leader. This logbook will contain a daily summary of all the team activities, problems encountered, deviations from the sampling and analysis plan, visitor log, and list of site contacts. This logbook will be signed and dated at the end of each day's drilling or sampling activities.

6.1.3.5 Field Instrument Calibration/Standardization Logbook. Each piece of equipment requiring periodic calibration or standardization will have a logbook to record equipment calibration data. This logbook will contain logsheets to record the date, time, method of calibration, and instrument identification number (see Appendix C).

6.1.3.6 Sample Shipping Logbook. This logbook will be used to record the sample ID number, collection date, shipping date, cooler ID number, destination, date shipped, chain-of-custody number, sample shipping classification, name of shipper, and QA check (see Appendix C).

6.1.4 Data Sheets

In addition to field logbooks, data sheets will be used to record field information. A water level data sheet, a slug test data sheet, or a transducer data sheet will be used to record pertinent information when

measuring water level in wells or when performing slug tests. Figure 6-3 is an example of a data sheet.

6.2 SAMPLE HANDLING

Tables 6-1 and 6-2 outline generic requirements for containers, preservation methods, sample volumes, and holding times for solid and aqueous samples. Specific requirements pertaining to the types of samples and analytes involved in this project will be followed as prescribed in the tables. All containers will be obtained from I-Chem or an equivalent, EPA-approved supplier for Superfund sites. Containers will be precleaned and so certified by the supplier. The following container quality records will be obtained and submitted to ARDC:

- The procedure used to clean all sample containers
- Certification from the supplier that all containers were cleaned per the procedure.

Containers for VOC and nitrate/nitrite samples will be precleaned in the following manner:

- Laboratory grade detergent wash and rinse
- Multiple deionized water rinses
- Oven drying, capping, and packing to prevent dust fall contamination.

Containers for all other samples will be precleaned as follows:

- Laboratory grade detergent wash and rinse
- Acid, deionized water, and solvent rinses
- Oven drying, capping, and packing under QC conditions.

Contaminated sample containers will not be reused. They will be disposed of onsite or at the laboratories. Onsite disposal will be coordinated with site waste disposal personnel.

SLUG TEST DATA SHEET

Well _____

Date _____

Observer(s) _____

Equipment

Data Logger Serial Number _____

Slugger Type _____

Transducer Serial Number _____

Scale Factor _____

Rating (psi) _____

Time of Start _____

Time of Finish _____

Test Number _____

Depth to Water _____

Reference Mark _____

Transducer Check

Second Reading (___ ft deeper) _____

First Reading _____

Difference _____

(The transducer should be accurate
to within $\pm 1\%$ of the measured value)

First Trial

Second Trial

Transducer Depth

Depth to water below reference mark _____

Depth of transducer below water _____

Depth of transducer below reference mark _____

Referenced prior to pressurization

YES

NO

PreTest

Well Gauge Pressure _____

Regulator Pressure _____

Data Logger Test No. _____

Record water level at 0.5 min YES NO
and print

Remarks

Figure 6-3. Slug test data sheet.

Table 6-1. Typical sample requirements—aqueous samples

Analytical Parameter	Container		Preservative	Holding Time ^a	Sample Volume ^a
	Size	Type			
Volatile organics	40 ml	Glass vial w/ teflon septa	4°C and 1:1 HCL to pH < 2	14 days	80 ml/2-40 ml (6 x 40 ml for full QC)
CLP metals	1000 ml	HDPE (NM)	pH < 2, HNO ₃	6 months, Hg 28 days	1000 ml
Gross alpha, beta	125 ml	HDPE	pH < 2, HNO ₃	Screen immediately	100 ml
Gamma spectrometry analysis	540 ml	Plastic bottles	pH < 2, HNO ₃	1 year	500 ml
Sr-90	1000 ml	HDPE (NM)	pH < 2, HNO ₃	--	1000 ml
Tritium	125 ml	HDPE (NM)	None	1 year	100 ml
Alkalinity	250 ml	Glass	4°C	ASAP (none given)	50 ml
Fluoride	1000 ml	HDPE	4°C	48 hours	50 ml
Sulfate/chloride	500 ml	Glass	4°C	28 days	50 ml
Nitrate/nitrite	500 ml	Glass	2 ml H ₂ SO ₄ per liter sample as specified if H.T. > 24 hrs	ASAP must be preserved	250 ml

a. Holding times are from date of collection as referred to in Federal Register Vol. 49, No. 209, October 26, 1984.

b. All samples will be collected unfiltered.

Table 6-2. Typical sample requirements—physical, geochemical, and mineralogic samples (interbed and core samples)

<u>Analytical Parameter</u>	<u>Container</u>		<u>Preservative</u>	<u>Holding Time</u>	<u>Sample Volume</u>
	<u>Size</u>	<u>Type</u>			
Physical properties ^a	2 ft	Shelby Tube	None	None	2 ft intact core
Geochemical ^b	1,000 ml	(WM) polyethylene	None	None	500 g

a. As defined in Table 3-1 and 3-7.
b. As defined in Table 3-1 and 3-8.

6.2.1 Sample Preservation

Preservation of all samples will be performed immediately upon sample collection. The temperature will be checked periodically and recorded prior to shipment to ensure adequate preservation for those samples requiring temperatures at 4°C for preservation. Each field team will be equipped with field sample preservation kits, which may include nitric acid, sulfuric acid, hydrochloric acid, and pH indicator paper. Ice chests (coolers) containing frozen blue ice will be used to chill samples, if required, in the field after sample collection. For the TAN groundwater investigation, acid will be used to preserve aqueous samples when required.

6.2.2 Chain of Custody Procedures

To maintain and document sample possession, chain of custody (COC) procedures will be followed per ERD PD 5.7 and the QAPjP. The purpose of COC is to document the identity of a sample and its handling from the point of collection until laboratory analysis is complete. The COC record will be a multiple-copy form, which serves as a written record of the sample handling. When a sample changes custody, the person(s) relinquishing and receiving the sample will sign a COC record. Each change of possession will be documented. Thus, a written record tracking sample handling will be established.

COC procedures will begin immediately after sample collection. COC forms (Figure 6-4) will be initiated the day of sample collection. Sample bottles will be stored in a secured area accessible only to the field team members. The secureness of the lids on the containers will be checked before shipping the container to the analytical laboratory.

6.2.3 Transportation of Samples

All short-holding-time samples will be shipped "priority one/overnight" via Federal Express through the Federal Express Office, in accordance with the regulations issued by the Department of Transportation (DOT) (49 CFR Parts 171 through 178) and EPA sample handling, packaging, and shipping methods (40 CFR 261.C.3C.3).

6-11

Figure 6-4. Chain of custody form.

Figure 6-4. Chain of custody form.

All samples will be packaged and transported in a manner that protects the integrity of the sample and prevents sample leakage. Packaging procedures will vary, depending on the suspected sample concentrations and DOT hazard class. Figure 6-5 depicts a properly packaged and labeled cooler containing nonradioactive environmental samples for shipment to the analytical laboratory. Figure 6-6 depicts the proper packaging and labeling for limited quantity radioactive samples (see Section 6.2.3.3). The temperature of each batch of coolers (i.e., those arriving at the same time) will be checked. One cooler per batch will be opened, a thermometer will be placed inside and allowed to equilibrate, and the temperature will be recorded in a logbook by personnel at the analytical laboratory. The laboratory will communicate these temperatures to the field to ensure adequate coolant is used to cool the samples during shipment.

6.2.3.1 Field Radiation Screening Procedures. Qualified EG&G Idaho personnel will perform sample radiation screening in the field for shipping purposes. Sample screening is necessary to determine whether or not the sample must be shipped as a radioactive shipment, how it should be packaged, and to which laboratory it can be shipped for analysis. All sample screening will be performed with hand-held instruments that have been properly calibrated before field use. All results will be recorded in the appropriate logbook (i.e., sample logbook, existing well logbook, etc.).

The first step in field radiation screening will consist of surveying for alpha, beta, and gamma radiation. The second step in field radiation screening will consist of a contact beta-gamma survey of the outside of the sample container once it is filled and the lid has been replaced. Readings will be taken on all sides of sample bottles that contain potentially nonuniform samples (e.g., soil or sludge samples). A contact reading will be taken on the bottom of all liquid samples to screen any particles that may have settled to the bottom of the sample bottle.

6.2.3.2 Green Tag. All samples and field equipment will be surveyed by the Health Physics Technician for radiological contamination. If the samples are determined to be nonradioactive (beta-gamma activity is less than 100 cpm above background and the HP determines no alpha activity), the Health Physics Technician will release the sample so it may leave the site. Samples that do

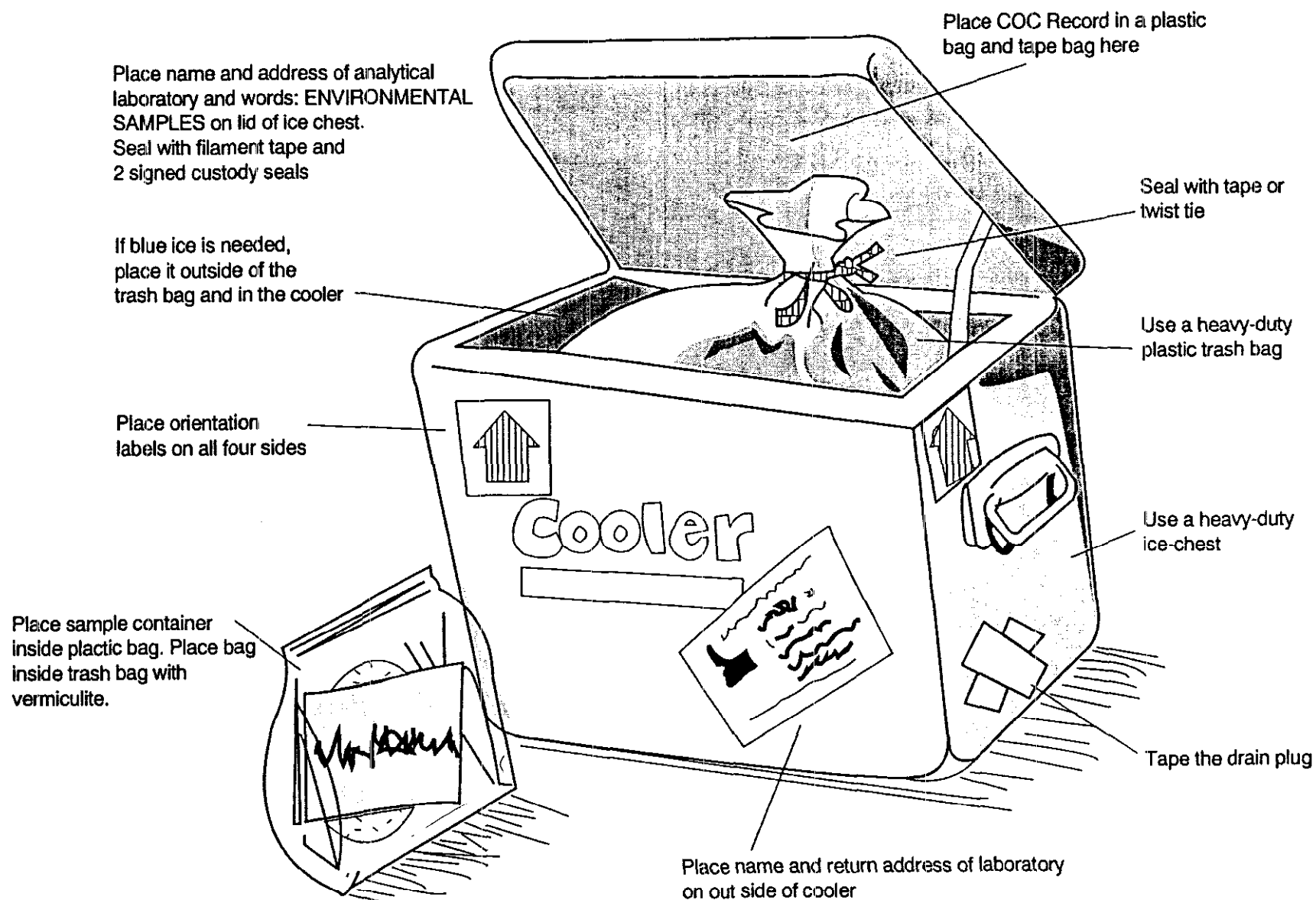


Figure 6-5. Packaging of environmental samples for shipment to the analytical laboratory.

Place notice on paint can or in ziplock bag with COC form.

Notice should be signed and dated.

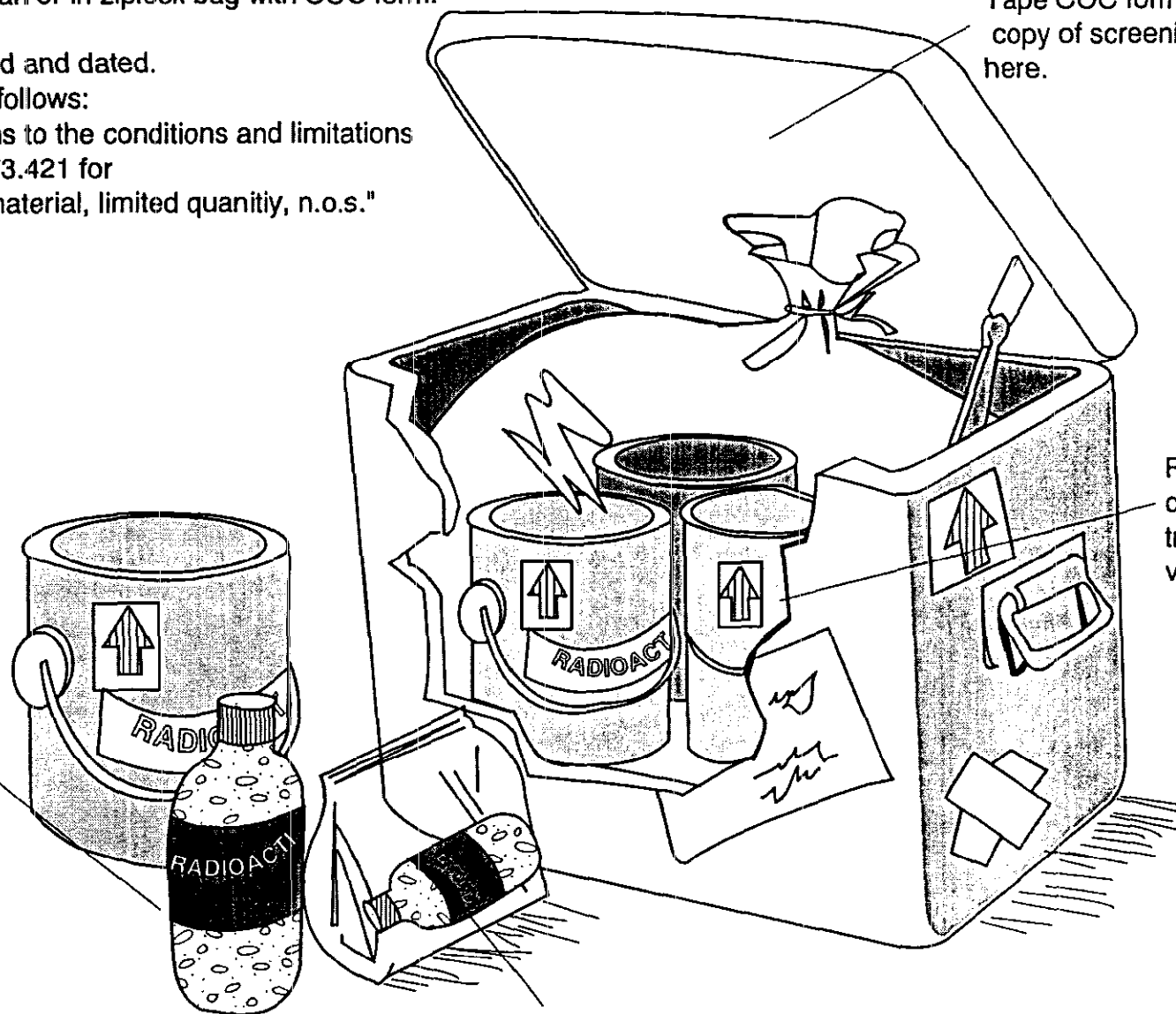
Notice should read as follows:

"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for excepted radioactive material, limited quantity, n.o.s."

Tape COC form, and copy of screening results here.

6-14

Place radioactive label on sample bottle or sample tag or ziplock bag or metal paint can.



Place paint cans inside trash bag with vermiculite.

Place bottle inside ziplock bag.
Place bag in paint can with vermiculite.

Figure 6-6. Packaging of limited quantity of radioactive samples for shipment to the analytical laboratory.

not meet this criteria will be handled and packaged according to Section 6.2.3.3 below.

6.2.3.3 Packaging of Radioactive Materials. Samples collected from aquifer wells are not expected to be radioactive. However, if activity is detected with a hand-held instrument, an aliquot of the sample will be sent to the RML for a gamma scan characterization. Based on this characterization, samples will be packaged accordingly.

Radioactive samples will be packaged to protect the health and safety of personnel and the public, following the steps outlined below.

1. Place sample bottle, properly labeled and sealed, into a plastic bag and then into a DOT 7A Type A drum (2 per drum) such that the bag is surrounded on all sides with an absorbent cushioning material (i.e., vermiculite). Securely affix top of drum.
2. Place evidence tape on the drum so it must be broken if the drum was opened.
3. Place a "This Side Up" label on the drum top and indicate the top with arrows on the side of the drum.
4. Place a label on the outside of the can specifying the proper shipping name associated with the sample.
5. Put a layer of absorbent cushioning material in the bottom of a hard plastic-lined metal cooler.
6. Place the cans into the cooler with the proper end up. Tape the drain plug shut so that the plug will not open, and fill in around the cans with additional absorbent cushioning material.
7. If required, include sealed containers of ice before closing cooler.
8. Enclose a chain of custody form sealed in a plastic bag inside one cooler, one per shipment.
9. Seal the space between the cooler lip and lid with fiberglass tape.
10. Make several wraps around the cooler perpendicular to the seal to ensure the lid will remain closed if the latch is accidentally released or damaged.
11. Label the cooler with the following information:
 - "Laboratory Samples" label
 - "This End Up" label on lid

- "This End Up" arrows on sides
 - White I or Radiation II label, properly completed
 - Address label with name, address, and phone number of receiving lab and a return address with the same information for the sender.
12. Have a Health Physics Technician onsite survey the cooler before taking it to Central Shipping and Receiving. This parcel is suitable to be shipped to the laboratory by commercial air cargo transporter, rail, or truck.

Samples are not expected to exceed limited quantity radioactivity levels but will be individually surveyed, and any sample exceeding 0.5 mR/hr at contact will be sent to the RML for gamma spectrometry analysis. Limited quantity radioactive samples will be properly packaged according to Figure 6-6.

6.2.3.4 Custody Seals. Custody seals will be placed on all shipping containers. Clear, plastic tape will be placed over the seals to ensure that the seals are not accidentally broken during shipment.

6.2.3.5 Onsite Shipping. An onsite shipment is any transfer of material within the perimeter of the INEL. Site-specific requirements for transporting of samples within Site boundaries and those required by the shipping/receiving department will be followed. Shipments within INEL boundaries will conform to DOT requirements, as stated in 49 CFR.

6.2.3.6 Approvals Needed for Transportation of Samples. Transportation of radioactive and hazardous samples onsite and offsite will be coordinated with EG&G Idaho shipping personnel. These arrangements will be made prior to the onset of field sampling activities.

7. REFERENCES

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APPENDIX A
SAMPLING AND ANALYSIS PLAN TABLES

SAP Number: EGG-WM-9905-GW

SAP Table No. 1

Date: 03/27/92

Revision: 4.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: TAN GROUND WATER RI/FS - GROUND WATER - I

Project Manager: G. J. STORMBERG

Page 1 of 4

Form No: SAP11B

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										A1	C1	D4	DV	F1	FV	N2	R4	R6	RB	RB	SC								
1TQ001	REG	GROUND WATER	GRAB		04/21/92	TAN	USGS-24	EXISTING USGS	255-275	1	1		1	1		1	1	1	1	1	1								
1TQ002	REG	GROUND WATER	GRAB		04/21/92	TAN	USGS-26	EXISTING USGS	240-265	1	1		1	1		1	1	1	1	1	1								
1TQ003	REG	GROUND WATER	GRAB		04/21/92	TAN	ANP-6	EXISTING USGS	230-250	1	1		1	1		1	1	1	1	1	1								
1TQ004	REG	GROUND WATER	GRAB		04/21/92	TAN	ANP-8	EXISTING USGS	233-301	1	1		1	1		1	1	1	1	1	1								
1TQ005	REG	GROUND WATER	GRAB		04/21/92	TAN	ANP-9	EXISTING USGS	240-260	1	1		1	1		1	1	1	1	1	1								
1TQ006	REG	GROUND WATER	GRAB		04/21/92	TAN	IET DISPOSAL	EXISTING USGS	220-240	2	2		2	2		2	2	2	2	2	2								
1TQ007	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN DISPOSAL 1	EXISTING USGS	285-305	1	1		1	1		1	1	1	1	1	1								
1TQ008	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN DISPOSAL 2	EXISTING USGS	205-220	1	1		1	1		1	1	1	1	1	1								
1TQ009	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN DISPOSAL 3	EXISTING USGS	240-260	1	1		1	1		1	1	1	1	1	1								
1TQ010	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-1	EXISTING USGS	200-360	2	2		2	2		2	2	2	2	2	2								
1TQ011	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-2	EXISTING USGS	235-345	1	1		1	1		1	1	1	1	1	1								
1TQ012	REG	GROUND WATER	GRAB		04/21/92	TAN	FET-2	EXISTING USGS	215-230	1	1		1	1		1	1	1	1	1	1								
1TQ013	REG	GROUND WATER	GRAB		04/21/92	TAN	TSF05 INJECTION	EXISTING USGS	240-250	2	2		2	2		2	2	2	2	2	2								
1TQ014	REG	GROUND WATER	GRAB		04/21/92	TAN	GIN-4	EXISTING USGS	240-260	1	1		1	1		1	1	1	1	1	1								
1TQ015	REG	GROUND WATER	GRAB		04/21/92	TAN	GIN-2	EXISTING USGS	240-260	1	1		1	1		1	1	1	1	1	1								

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
 Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
 Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

COMMENTS

AT1: Alkalinity
 AT2: CLP Metals
 AT3: Drinking Water VOAs (524.2) IV
 AT4: Drinking Water VOAs (524.2) III
 AT5: Fluoride
 AT6: GC VOAs Method 8010
 AT7: Nitrate/Nitrite
 AT8: Gamma Spectroscopy
 AT9: Gross Alpha/Beta
 AT10: Tritium

AT11: Strontium-90
 AT12: Sulfate/Chloride
 AT13: _____
 AT14: _____
 AT15: _____
 AT16: _____
 AT17: _____
 AT18: _____
 AT19: _____
 AT20: _____

Date: 03/27/92

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Page 2 of 4

Revision: 4.0

Project: TAN GROUND WATER RI/FS - GROUND WATER - I

Project Manager: G. J. STORBERG

Form No: SAP11B

SAMPLE DESCRIPTION					PLANNED DATE	SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD		AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										A1	C1	D4	DV	F1	FV	N2	R4	R6	R8	RB	SC								
1TQ016	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-3	EXISTING RFI	230-260	1	1		1	1		1	1	1	1	1	1								
1TQ017	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-4	EXISTING RFI	220-245	1	1		1	1		1	1	1	1	1	1								
1TQ018	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-5	EXISTING RFI	280-300	1	1		1	1		1	1	1	1	1	1								
1TQ019	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-6	EXISTING RFI	230-250	1	1		2	1		1	1	1	1	1	1								
1TQ020	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-7	EXISTING RFI	300-320	1	1		1	1		1	1	1	1	1	1								
1TQ021	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-8	EXISTING RFI	220-240	1	1		1	1		1	1	1	1	1	1								
1TQ022	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-9	EXISTING RFI	300-320	1	1		1	1		1	1	1	1	1	1								
1TQ023	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-10A	EXISTING RFI	215-245	1	1		1	1		1	1	1	1	1	1								
1TQ024	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-11	EXISTING RFI	290-310	1	1		1	1		1	1	1	1	1	1								
1TQ025	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-12	EXISTING RFI	360-380	1	1		1	1		1	1	1	1	1	1								
1TQ026	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-13A	EXISTING RFI	230-250	1	1		1	1		1	1	1	1	1	1								
1TQ027	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-14	EXISTING RFI	360-380	1	1		1	1		1	1	1	1	1	1								
1TQ028	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-15	EXISTING RFI	230-250	1	1		1	1		1	1	1	1	1	1								
1TQ029	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-16	EXISTING RFI	300-320	1	1		1	1		1	1	1	1	1	1								
1TQ030	REG	GROUND WATER	GRAB		04/21/92	TAN	TAN-17	EXISTING RFI	260-280	1	1		1	1		1	1	1	1	1	1								

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below. COMMENTS

COMMENTS

AT1: Alkalinity

AT2: CLP Metals

AT3: Drinking Water VOAs (524.2) IV

AT4: Drinking Water VOAs (524.2) III

ATS: Fluoride

AT6: GC VOAs Method 8010

AI7: Nitrate/Nitrite

ATB: Gamma Spectroscopy

AT9: Gross Alpha/Beta

AT10: Tritium

AT11: Strontium-90

AT12: Sulfate/Chloride

AT13:

AT14:

AT15:

AT16:

AT17:

AT 18:

AT 19:

AT20:

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

SAP Table No. 1
Date: 03/27/92 Revision: 4.0

Project: TAN GROUND WATER RI/FS - GROUND WATER - 1

Project Manager: G. J. STORMBERG

SAMPLE DESCRIPTION					SAMPLE LOCATION					ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL. TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
170031	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-18	NEW WELLS	UNKNOWN	1	1	1	1	1	1	1	1	1	1	1	1								
170032	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-19	NEW WELLS	UNKNOWN	2	2	2	2	2	2	2	2	2	2	2	2	2							
170033	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-20	NEW WELLS	UNKNOWN	1	1	1	1	1	1	1	1	1	1	1	1	1							
170034	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-21	NEW WELLS	UNKNOWN	1	1	1	1	1	1	1	1	1	1	1	1	1							
170035	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-22	NEW WELLS	UNKNOWN	1	1	1	1	1	1	1	1	1	1	1	1	1							
170036	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-23	NEW WELLS	UNKNOWN	1	1	1	1	1	1	1	1	1	1	1	1	1							
170037	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-24	NEW WELLS	UNKNOWN	2	2	2	2	2	2	2	2	2	2	2	2	2							
170038	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-18	BOREHOLE	A						3														
170039	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-19	BOREHOLE	A						3														
170040	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-19	BOREHOLE	B						3														
170041	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-19	BOREHOLE	C						3														
170042	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-19	BOREHOLE	D						6														
170043	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-19	BOREHOLE	D			1																	
170044	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-20	BOREHOLE	A						3														
170045	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-21	BOREHOLE	A						3														

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.

Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.

Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

COMMENTS

AT1: Alkalinity	AT11: Strontium-90
AT2: GLP Metals	AT12: Sulfate/Chloride
AT3: Drinking Water VOA (524.2) IV	AT13:
AT4: Drinking Water VOA (524.2) III	AT14:
AT5: Fluoride	AT15:
AT6: GC VOA Method 8010	AT16:
AT7: Nitrate/Nitrite	AT17:
AT8: Gamma Spectroscopy	AT18:
AT9: Gross Alpha/Beta	AT19:
AT10: Tritium	AT20:

SAP Number: EGG-WM-9905-GW

SAP Table No. 1

Date: 03/27/92

Revision: 4.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: TAN GROUND WATER RI/FS - GROUND WATER - I

Project Manager: G. J. STORMBERG

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Form No: SAP118

SAMPLE DESCRIPTION						SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
1TQ046	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-21	BOREHOLE	B						3														
1TQ047	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-21	BOREHOLE	C						3														
1TQ048	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-21	BOREHOLE	D						3														
1TQ049	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-21	BOREHOLE	E						3														
1TQ050	REG	GROUND WATER	GRAB		06/15/92	TAN	TAN-22	BOREHOLE	A						3														
1TQ051	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-23	BOREHOLE	A						3														
1TQ052	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-23	BOREHOLE	B						3														
1TQ053	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-23	BOREHOLE	C						3														
1TQ054	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-23	BOREHOLE	D						3														
1TQ055	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-23	BOREHOLE	D				1																
1TQ056	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-24	BOREHOLE	A						3														
1TQ057	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-24	BOREHOLE	B						3														
1TQ058	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-24	BOREHOLE	C						3														
1TQ059	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-24	BOREHOLE	D						3														
1TQ060	REG	GROUND WATER	GRAB		06/01/92	TAN	TAN-24	BOREHOLE	E						6														

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
 Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
 Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

COMMENTS

AT1: Alkalinity
 AT2: CLP Metals
 AT3: Drinking Water VOAs (526.2) IV
 AT4: Drinking Water VOAs (526.2) III
 AT5: Fluoride
 AT6: GC VOAs Method 8010
 AT7: Nitrate/Nitrite
 AT8: Gamma Spectroscopy
 AT9: Gross Alpha/Beta
 AT10: Tritium

AT11: Strontium-90
 AT12: Sulfate/Chloride
 AT13: _____
 AT14: _____
 AT15: _____
 AT16: _____
 AT17: _____
 AT18: _____
 AT19: _____
 AT20: _____

Date: 03/27/92

Revision: 3.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: TAN GROUND WATER RI/FS - GROUND WATER OC - I

Page 1 of 1

Project Manager: G. J. STORMBERG

Form No: SAP11B

[illegible]

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions. Enter the number of bottles in the single line boxes below the analysis type for each sampling activity. Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below. COMMENTS

COMMENTS

AT1: Alkalinity

AT2: CLP Metals

AT3: Drinking Water VOAs (524.2) IV

AT4: Drinking Water VOAs (524.2) III

AT5: Fluoride

AT6: GC VOAs Method 8010

AT7: Nitrate/Nitrite

AT8: Gamma Spectroscopy

AT9: Gross Alpha/Beta

AT10: Tritium

AT11: Strontium-90

AT12: Sulfate/Chloride

AT13: _____

AT14: _____

AT15: _____

AT16: _____

AT17: _____

AT18: _____

AT19: _____

AT20: _____

SAP Table No. 1
Date: 03/27/72

Revision: 2.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: TAIN GROUND WATER RI/FS - INTERBEDS - I

Page 1 of 1

Project Manager: G. J. STORMBERG

Form No: SAP11B

[illegible]

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions. Enter the number of bottles in the single line boxes below the analysis type for each sampling activity. Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below. COMMENTS

COMMENTS

AT1: Mineralogical/Geochemical Properties

AT13:

AT2: Physical Properties

AT12:

AT3:

AT13:

AT4:

AT 14:

AT5:

AT15:

AT6:

AT 16:

AT7:

AT17:

ATB:

AT 18:

ATQ:

AT 19:

AT10:

AT20:

Mineralogical/Geochemical Properties (GP) include:

X-Ray Diffraction

Cation Exchange Capacity

Total Organic Carbon

NOTE: Samples will be collected from interbed boreholes (2 interbeds, 2 holes).

SAP Table No. 1
Date: 03/27/92

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Revision: 2.0

Project: TAN GROUND WATER RI/FS - BASALT - I

Project Manager: G. J. STORMBERG

Form No: SAP11B

[illegible]

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions. Enter the number of bottles in the single line boxes below the analysis type for each sampling activity. Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below. COMMENTS

COMMENTS

AT1: Mineralogical/Geochemical Properties

ATTN:

AT2:

AT12:

AT3:

AT 13:

AT4:

AT14:

ATS:

ATTS:

AT6:

AT16:

AT7:

AT17:

ATB:

AT18:

ATQ:

AT19:

ATTN:

AT20:

Mineralogical/Geochemical Properties (GP) include:

X-ray Diffraction

Cation Exchange Capacity

NOTE: Existing basalt cores will be analyzed from library.

SAP Table NO. 1
Date: 03/27/92

Project: TAM GROUND WATER RI/FS - PORTABLE WATER TREATMENT UNIT - I

Form No: SAP11B

[illegible]

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.
Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.
Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below. COMMENTS

COMMENTS

AT1: CLP Volatiles

AT2: Gamma Screen

AT3: Gross Alpha/Beta

AT4: TCLP Metals/Semis/Pests/Herbs

AT5: TCLP Volatiles

AT6: Ignit/Corrosivity/Reactivity

AT7: _____

AT8: _____

AT9: _____

AT10: _____

AT11: _____
AT12: _____
AT13: _____
AT14: _____
AT15: _____
AT16: _____
AT17: _____
AT18: _____
AT19: _____
AT20: _____

OTHR = Media may consist of activated carbon, sediments, and spent sediment trap prefilters. The number of samples and media type are estimates only.

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: TAN GROUNDWATER R1/FS - HOLDING TANK - I

Project Manager: G. J. STORMBERG

SAP Number: EGG-UM-9905-U
SAP Table No. 1
Date: 03/27/92 Revision: 1.0

SAMPLE DESCRIPTION					SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																				
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL. TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										C1	CV	DS	R5	R6															
1TW001	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	2	2	2	2	2															
1TW002	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW003	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW004	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW005	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW006	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW007	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW008	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW009	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW010	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW011	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW012	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW013	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW014	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															
1TW015	REG	WATER	GRAB		07/15/92	TAN	HOLDING TANK	UTR TRMT PLANT	N/A	1	1	1	1	1															

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions. Enter the number of bottles in the single line boxes below the analysis type for each sampling activity. Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

COMMENTS

Water samples are collected after treatment through the Portable Water

Treatment Unit. Sample quantities are estimates only.

- AT1: CLP Metals
AT2: CLP Volatiles
AT3: CLP Semi-volatiles
AT4: Gamma Screen
AT5: Gross Alpha/Beta
AT6:
AT7:
AT8:
AT9:
AT10:
AT11:
AT12:
AT13:
AT14:
AT15:
AT16:
AT17:
AT18:
AT19:
AT20:

Date: 03/27/92

Revision: 1.0

Project: TAN GROUNDWATER RI/FS - HOLDING TANK - I

Project Manager: G. J. STORMBERG

Page 2 of 2

Form No: SAP118

[illegible]

COMMENTS

AT1: CLP Metals

AT2: CLP Volatiles

AT3: CLP Semivolatiles

AT4: Gamma Screen

AT5: Gross Alpha/Beta

AT6: _____

AT7: _____

AT8: _____

AT9: _____

AT10: _____

AT11: _____

AT12: _____

AT13: _____

AT14: _____

AT15: _____

AT16: _____

AT17: _____

AT18: _____

AT19: _____

AT20: _____

Water samples are collected after treatment through the Portable Water Treatment Unit. Sample quantities are estimates only.

A-12

Date: 03/27/92

Revision: 0.0

Project: TAN GROUND WATER RI/FS - INJECTION WELL - 1

Project Manager: G. J. STORMBERG

Page 1 of 1

Form No: SAP11B

[illegible]

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions. Enter the number of bottles in the single line boxes below the analysis type for each sampling activity. Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below. COMMENTS

COMMENTS

AT1: CLP Metals

AT2: CLP Volatiles

AT3: CLP Semivolatiles

AT4: Gamma Spectroscopy

AT5: Gross Alpha/Beta

ATG:

AT7:

ATB:

AT9:

AT10:

AT#1:

AT12:

AT13:

AT14:

AT15:

AT16:

AF17:

AT18:

AT19:

AT20:

SAP Number: EGG-WM-9905-GW2

SAP Table No. 1

Date: 03/27/92

Revision: 2.0

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

Project: TAN GROUND WATER RI/FS - GROUND WATER - II

Project Manager: G. J. STORMBERG

Page 1 of 3

Form No: SAP118

SAMPLE DESCRIPTION					PLANNED DATE	SAMPLE LOCATION				ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL TYPE	SAMPLING METHOD		AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
										A1	C1	D4	DV	F1	N2	R4	R6	R8	RB	SC									
1TQ101	REG	GROUND WATER	GRAB		10/01/92	TAN	USGS-24	EXISTING USGS	255-275	2	2		2	2	2	2	2	2	2	2									
1TQ102	REG	GROUND WATER	GRAB		10/01/92	TAN	USGS-26	EXISTING USGS	240-265	1	1		1	1	1	1	1	1	1	1									
1TQ103	REG	GROUND WATER	GRAB		10/01/92	TAN	AMP-6	EXISTING USGS	230-250	1	1		1	1	1	1	1	1	1	1									
1TQ104	REG	GROUND WATER	GRAB		10/01/92	TAN	AMP-8	EXISTING USGS	233-301	1	1		1	1	1	1	1	1	1	1									
1TQ105	REG	GROUND WATER	GRAB		10/01/92	TAN	AMP-9	EXISTING USGS	240-260	1	1		1	1	1	1	1	1	1	1									
1TQ106	REG	GROUND WATER	GRAB		10/01/92	TAN	IET DISPOSAL	EXISTING USGS	220-240	1	1		1	1	1	1	1	1	1	1									
1TQ107	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN DISPOSAL 1	EXISTING USGS	285-305	1	1		1	1	1	1	1	1	1	1									
1TQ108	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN DISPOSAL 2	EXISTING USGS	205-220	1	1		1	1	1	1	1	1	1	1									
1TQ109	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN DISPOSAL 3	EXISTING USGS	240-260	1	1		1	1	1	1	1	1	1	1									
1TQ110	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-1	EXISTING USGS	200-360	1	1		1	1	1	1	1	1	1	1									
1TQ111	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-2	EXISTING USGS	235-345	2	2		2	2	2	2	2	2	2	2									
1TQ112	REG	GROUND WATER	GRAB		10/01/92	TAN	FET-2	EXISTING USGS	215-230	1	1		1	1	1	1	1	1	1	1									
1TQ113	REG	GROUND WATER	GRAB		10/01/92	TAN	TSF05 INFECTION	EXISTING USGS	240-250	1	1		1	1	1	1	1	1	1	1									
1TQ114	REG	GROUND WATER	GRAB		10/01/92	TAN	GIN-4	EXISTING USGS	240-260	1	1		1	1	1	1	1	1	1	1									
1TQ115	REG	GROUND WATER	GRAB		10/01/92	TAN	GIN-2	EXISTING USGS	240-260	1	1		1	1	1	1	1	1	1	1									

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions.

Enter the number of bottles in the single line boxes below the analysis type for each sampling activity.

Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

COMMENTS

AT1: Alkalinity

AT2: CLP Metals

AT3: Drinking Water VOAs (524.2) IV

AT4: Drinking Water VOAs (524.2) III

AT5: Fluoride

AT6: Nitrate/Nitrite

AT7: Gamma Spectroscopy

AT8: Gross Alpha/Beta

AT9: Tritium

AT10: Strontium-90

AT11: Sulfate/Chloride

AT12: _____

AT13: _____

AT14: _____

AT15: _____

AT16: _____

AT17: _____

AT18: _____

AT19: _____

AT20: _____

SAMPLING AND ANALYSIS PLAN TABLE FOR CHEMICAL AND RADIOLOGICAL ANALYSIS

SAMPLE DESCRIPTION					SAMPLE LOCATION					ENTER ANALYSIS TYPES (AT) AND QUANTITY REQUESTED																			
SAMPLING ACTIVITY	SAMPLE TYPE	MEDIA	COLL. TYPE	SAMPLING METHOD	PLANNED DATE	AREA	LOCATION	TYPE OF LOCATION	DEPTH (ft)	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11	AT12	AT13	AT14	AT15	AT16	AT17	AT18	AT19	AT20
11Q131	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-18	NEW WELLS	UNKNOWN	1	1	1		1	1	1	1	1	1										
11Q132	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-19	NEW WELLS	UNKNOWN	1	1	1		1	1	1	1	1	1										
11Q133	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-20	NEW WELLS	UNKNOWN	2	2	2		2	2	2	2	2	2										
11Q134	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-21	NEW WELLS	UNKNOWN	2	2	2		2	2	2	2	2	2										
11Q135	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-22	NEW WELLS	UNKNOWN	1	1	1		1	1	1	1	1	1										
11Q136	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-23	NEW WELLS	UNKNOWN	1	1	1		1	1	1	1	1	1										
11Q137	REG	GROUND WATER	GRAB		10/01/92	TAN	TAN-24	NEW WELLS	UNKNOWN	1	1	1		1	1	1	1	1	1										

Enter the appropriate analysis type code in the boxes between the double lines under "ENTER ANALYSIS TYPES". Refer to SAP Table 2, Sampling And Analysis Plan Table - Codes & Descriptions. Enter the number of bottles in the single line boxes below the analysis type for each sampling activity. Any descriptions for non-standard analysis types (not given in SAP Table 2) should be entered under "COMMENTS" on the lines below.

AT1: Alkalinity	AT11: Sulfate/Chloride
AT2: CLP Metals	AT12:
AT3: Drinking Water VOA's (524.2) IV	AT13:
AT4: Drinking Water VOA's (524.2) III	AT14:
AT5: Fluoride	AT15:
AT6: Nitrate/Nitrite	AT16:
AT7: Gamma Spectroscopy	AT17:
AT8: Gross Alpha/Beta	AT18:
AT9: Tritium	AT19:
AT10: Strontium-90	AT20:

APPENDIX B
FIELD SAMPLING METHODS

APPENDIX B

FIELD SAMPLING METHODS

The following field sampling methods pertain to sample collection and/or field measurements. Procedures for drilling, coring and well installation/development can be found in the statement of work associated with the drilling contract(s). This appendix contains the following numbered methods:

FSM No.

1.	Water level measurements with an electronic recorder	B-4
2.	Water level measurements with a steel measuring tape	B-5
3.	Well sampling with a bailer	B-6
4.	Well purging and sampling with a submersible pump	B-7
5.	Well purging with a hydrostar piston pump	B-9
6.	Pneumatic slug test	B-11
7.	Hydrolab operation	B-15
8.	Decontamination	B-29
9.	Natural gamma ray well logging	B-32
10.	Gamma-gamma well logging	B-33
11.	Caliper well logging	B-34
12.	Neutron well logging	B-35
13.	Packer pumping test	B-36
14.	Groundwater sampling using a packer pump assembly	B-40
15.	Field screening of drill cuttings for VOCs and radionuclides .	B-41

FIELD SAMPLING METHOD (FSM #1)

WATER LEVEL MEASUREMENTS WITH AN ELECTRONIC RECORDER

Field Procedures:

1. Turn recorder to on position.
2. Check battery condition and continuity as recommended in the owners' manual. The continuity cell can be tested by placing it in water and observing the audio or visual signal.
3. Measurement markers that are crimped to the wire may slip or move out of place. Periodically, using a tape measure, check that the measurement markers on the wire have not been shifted. Measurement markers burned into the wire need not be checked.
4. Slowly lower the probe down the center of the casing until a contact with the water surface is indicated by the visual display or audio signal. Raise and lower the probe several times to ascertain water level. Record the measurement to the nearest 0.01 ft.

Note: If the tape is not incremented in 0.01 ft, measure (using folding ruler or tape measure with 0.01 ft increments) the distance from the "hold" mark to the nearest tape band or marker and add or subtract to the band or marker reading.

5. Repeat the reading before pulling out the electronic water level indicator.
6. Record all measurements (date, time, weather conditions, well site, and measuring point) in the field logbook.
7. Reel the probe out of the well.
8. Compare the depth to water (DTW) measurement with past measurements at this well if available. If the value is inconsistent with past values or if this is the first measurement at this well, repeat the measurement and record the results on the water level data form.
9. Water level elevation relative to mean sea level is found by subtracting the depth to water from the measuring point elevation.
10. At least once a day calibrate the electronic water level measuring device by duplicating a water level measurement with a steel tape.

FIELD SAMPLING METHOD (FSM #2)

WATER LEVEL MEASUREMENT WITH A STEEL MEASURING TAPE

Field Procedures:

1. Record date, time, weather conditions, well site, and measuring point on the water level data sheet or in the field logbook.
2. Chalk the lower segment (3-5 ft) of the tape by carefully drawing the tape across a piece of carpenter's chalk.
3. The weighted tape should be slowly lowered down the center of the casing or riser pipe until the tape penetrates the water surface. If previous measurements have been made at this well refer to them to estimate where to hold the measuring tape.
4. After water is encountered in the well, hold the tape at the closest even foot marker at the measuring point (typically top of well casing on north side). If a measuring point is not identified on the well casing or apron, mark the measuring point where the tape is held at the top of the casing so that successive measurements will be taken from the same point. Record the hold measurement in feet on the water level data sheet.
5. Pull or reel the measuring tape out of the well.
6. Record the measurement to the nearest 0.01 ft where the tape became wet.
7. Depth to water (DTW) can be found by subtracting the "wet" measurement from the "hold" measurement. Record depth to water to the nearest 0.01.
8. Water level elevation relative to mean sea level is found by subtracting the depth to water from the measuring point elevation.
9. Compare the DTW measurement with past measurements at this well if available. If the value is inconsistent with past values or if this is the first measurement at this well, repeat the measurement and record the results.

FIELD SAMPLING METHOD (FSM #3)

WELL SAMPLING WITH A BAILER

Field Procedures:

1. Remove well head cap, water level access port, and/or pump head, and survey with organic vapor detector.
2. Using precleaned equipment, determine the water level in the well (FSM #1 or 2). Calculate the fluid volume in the casing (see FSM #5).
3. Purge well by pumping (FSM #4) or bailing. Use the Hydrolab to record field measurements.
4. Attach a bailer that has been precleaned in accordance with FSM #8 to a clean cable or line for lowering.
5. Lower bailer slowly until it contacts the water surface.
6. Allow bailer to sink and fill with a minimum of surface disturbance.
7. Slowly raise bailer to surface. Do not allow bailer line to contact the ground.
8. Tip the bailer to allow slow discharge of water from the top of the bailer into sample bottle.
9. Repeat Steps 3 through 7 as needed to acquire a sufficient volume of water. Samples should be collected in the order and methods outlined in the Field Sampling Plan.
10. Preserve the samples if necessary (see FSP).
11. Check that a Teflon liner is present in the sample bottle cap if one is required. Secure the cap tightly.
12. Complete the information required on the sample bottle label. (See Sections 6.1.1 and 6.1.2). Record the information in the appropriate field logbooks (see Section 6.1.4) and complete all chain-of-custody documents (Section 6.2.2).
13. Place the properly labeled sample container in an appropriate carrying container and if required, maintain at 4°C throughout the sampling and transportation period.
14. Have samples surveyed by an HPT and tagged accordingly (if necessary) prior to packaging for shipment.
15. Decontaminate the bailer using the procedures described in FSM #8 prior to reuse.

FIELD SAMPLING METHOD (FSM #4)

WELL PURGING AND SAMPLING WITH A SUBMERSIBLE PUMP

Field Procedures:

1. Remove well head cap, water level access port, and/or pump head, and survey with organic vapor detector.
2. Using clean, noncontaminating equipment, determine the water level in the well (FSM #1 or 2). Then calculate the fluid volume in the casing, using the following formula: $v = 3.14r^2h$
Where: v = volume
 r = radius of the monitoring well (ft.)
 h = height of standing water in well (ft.)
3. Lower the precleaned pump (FSM #8) to just below the water level and begin pumping. Collect and contain purged water. Transport water to the TAN portable water treatment unit.
4. Frequently measure rate of discharge. A bucket and stopwatch are commonly used.
5. Purge a minimum of three casing volumes and until discharge pH, conductivity, and temperature stabilize. [Note: If the pump is constructed of materials compatible with the required sample analysis and if the well has recovered sufficiently (re-found water level), sample acquisition can proceed].
6. Use Hydrolab in accordance with FSM #7 (or operating manual) to monitor pH, temperature, and specific conductance. When three consecutive readings are within the limits listed below and three well casing volumes have been removed from the well, sampling may begin.

pH: ± 0.1 standard units

Temperature: $\pm 0.5^\circ\text{C}$

Specific conductance: ± 10 mmhos/cm
7. Fill and select appropriate sample bottles by allowing pump discharge to flow gently down the side of bottle with minimal entry turbulence. Samples should be collected using the order and methods outlined in the FSP.
8. Preserve the sample if necessary (see FSP).
9. Check that a Teflon liner is present in the sample bottle cap if one is required. Secure the cap tightly.
10. Complete the information required on the sample bottle label (Section 6.1.1 and 6.1.2). Complete chain-of-custody documents (Section 6.2.2) and appropriate field logbooks (See Section 6.1.4).

11. Place the properly labeled sample bottle in an appropriate carrying container and maintain at 4°C (if necessary) throughout the sampling and transportation period.
12. Have the samples surveyed by an HPT prior to packaging for shipment.
13. Decontaminate the pump and ancillary equipment using the procedures in FSM #8 prior to reuse.

FIELD SAMPLING METHOD (FSM #5)

WELL PURGING AND SAMPLING WITH A HYDROSTAR PISTON PUMP

Field Procedure:

1. Remove well head cap and water level access port or pump head, and survey with organic vapor detector.
2. Take water level measurement according to FSM #1 or 2 and record in appropriate logbook.
3. Replace access port cap.
4. Place pump motor on top of well head and attach piston arm with clevis pins.
5. Hook compressor line to pump motor and attach precleaned purge line to discharge port. Direct line downslope from the well head. Collect and contain all purge water. Transport water to the TAN portable water treatment unit.
6. A minimum of three well casing volumes of water, and until the pH, conductivity, and temperature stabilize, need to be removed prior to sampling the well. Calculate the volume of standing water in the well using the following formula:

$$v = 3.14r^2h,$$

where

v = volume

r = radius of the monitoring well casing (ft)

h = height of standing water in well (ft).

7. Begin pump/purge cycle. Record pump strokes per minute in the field logbook. Regulate pump rate with a bucket and stopwatch so maximum flow rate never exceeds 3 gpm. If the flow rate is less than the calculated rate on the table, make proper adjustments to ensure at least three well casing volumes are removed.
8. Use Hydrolab in accordance with FSM #7 (or Hydrolab operating manual) to monitor pH, temperature, and specific conductance. When three consecutive readings are within the limits listed below, and three well casing volumes have been removed from the well, sampling may begin.

pH: ± 0.1 standard units
Temperature: $\pm 0.5^\circ\text{C}$
Specific conductance: ± 10 mmhos/cm.

9. Remove purge line and attach a precleaned (FSM #8) teflon sampling line to the out flow port.
10. Adjust pump rate back to 0.1 gpm.
11. Collect samples directly from the teflon sample line by the order and methods outlined in the FSP. Care must be taken to avoid contact of the line with the interior of the bottles.

Note: Samples should be collected in the order outlined in the FSP.

12. Preserve the sample if necessary (see FSP).
13. Check that a Teflon liner is present in sample bottle cap if one is required. Secure the cap tightly.
14. Complete the information required on the label (Sections 6.1.1 and 6.1.2). Record the information in the appropriate field logbooks (Section 6.1.4), and complete all chain-of-custody documents (Section 6.2.2).
15. Place the properly labeled sample container in an appropriate carrying container and maintain at 4°C (if necessary) throughout the sampling and transportation period.
16. Have samples surveyed by a HPT and tagged accordingly prior to packaging for shipment.

FIELD SAMPLING METHOD (FSM #6)

PNEUMATIC SLUG TEST

To perform this test, the well must be cased with the open portion of the well below the water table. The casing must be sound with no air leaks between the pipe joints. The top of the well casing must be accessible and fitted with standard pipe threads.

Field Procedure:

1. Fill out the slug test data sheet as appropriate.
2. Check well head thread and clean if necessary, then apply teflon tape.
3. Screw on well head manifold using large pipe wrenches (apply equal pressure to the base of the manifold and the top of the well. Be careful not to break PVC casing).
4. Measure water level through transducer access port on well head manifold and record. Check transducer for calibration status.
5. Insert transducer through access port and lower to water table.
6. Lower transducer a few feet below the water table. Mark the location on transducer lead with duct tape.
7. Record reading.
8. Measure several feet from first mark and then mark the second depth with duct tape.
9. Lower transducer to second mark.
10. Record second reading and subtract first reading (see attached data sheet).
11. If readings vary more than 1% from the measured value recheck measurement between tape marks and repeat.
12. If the second trial fails then either the transducer is defective or the density of the water is non-standard. Resolve this question before proceeding.
13. Determine optimum well pressure. The air pressure in the well forces the water level down the well bore. It is essential that the air pressure does not push the water level below the well screen or transducer. Each psi of pressure will force the water level down

2.31 feet. Calculate the depth to the well screen and use the following equation to calculate the maximum pressure for the well:

$$\text{Maximum pressure} = (2.31 \times \text{depth of screen below water table}) \times 0.8$$

14. Set the transducer below the anticipated minimum water level in the well without pressurizing. Calculate the maximum transducer depth using the following equation:

$$\text{Maximum depth} = (2.31 \times \text{transducer rating}) \times 0.8$$

15. Install split rubber stopper around transducer lead and carefully tighten down domed cap.
16. Secure lead to well casing with tape so it won't slip. Be careful not to pinch or crimp lead.
17. Check transducer level and record.
18. Reference water level on data logger.
19. Secure nitrogen bottle so it won't fall over.
20. Attach regulator.
21. Attach inflation line from regulator to well head manifold.
22. Close quick release valve (on the well head manifold) and pressurize regulator.
23. Set data logger to record water levels at 30 second intervals and start (warning: Be sure to step test so as not to write over previous tests).
24. Slowly open regulator and pressurize well to previously calculated pressure.
25. Check for leaks (should be audible).
26. When gas pressure in well stabilizes (i.e., when data logger readings stabilize), stop logger and print record.
27. Reset data logger to record at a logarithmic scale (over write stabilization record after hard copy is printed).
28. Put on ear and eye protection, and turn off nitrogen bottle valve.
29. Simultaneously open quick release valve and start data logger.
30. When water level returns to reference level, stop test.
31. Save a copy of the data (either a hard copy or disk copy).
32. Determine if a second test is needed based on comparison of results with existing data.

33. If testing is completed, remove the equipment and decontaminate the transducer and leadwire (see FSM #8).

Slug Test Data Sheet

Well _____

Date _____

Observer(s) _____

Equipment

Data Logger Serial Number _____

Slugger Type _____

Transducer Serial Number _____

Scale Factor _____

Rating (psi) _____

Time of Start _____

Time of Finish _____

Test Number _____

Depth to Water _____

Reference Mark _____

Transducer Check

	First Trial	Second Trial
Second Reading (___ft deeper)	_____	_____
First Reading	_____	_____
Difference	_____	_____
(The transducer should be accurate to within $\pm 1\%$ of the measured value)		

Transducer Depth

Depth to water below reference mark	_____
Depth to transducer below water	_____
Depth of transducer below reference mark	_____
Referenced prior to pressurization	_____
	YES NO

PreTest

Well Gauge Pressure _____

Regulator Pressure _____

Data Logger Test No. _____

Record water level at 0.5 min YES NO
and print

Remarks

FIELD SAMPLING METHOD (FSM #7)

HYDROLAB OPERATION

Procedure: Calibration and Operation of the Hydrolab Surveyor II for pH, temperature, and conductivity measurements.

References: Operating Manual, Hydrolab Surveyor II, Hydrolab Corporation, 1986

Description:

Types of Data Collected: Information obtained from this procedure includes measurements of aqueous samples for pH, temperature, and conductivity. Additional procedures included in the Hydrolab Operating Manual provide the means for measuring dissolved oxygen, Oxidation-Reduction Potential, and depth.

Principle of Operation: After calibration procedures are completed, water samples are collected from the well head (or other water source) and measurements taken for pH, temperature, and conductivity. If dissolved oxygen and/or ORP measurements are necessary, they are also carried out assuming proper calibration procedures have been completed for these parameters. Field measurements for pH, temperature and conductivity will be collected during both well development and well purging activities to monitor groundwater quality.

Limitations: There are generally no limitations for the Hydrolab other than instrument design limitations, if proper calibration, operation and handling are observed. For additional information, see the Operation Manual for the Hydrolab.

Equipment Needs:

- 1) **System parts:** There are five main components to the basic Surveyor II. These are the display unit, the data cable, the sonde, the sample circulator, and the battery pack (see operator's manual for component function).
- 2) **Calibration equipment:** The following materials and equipment will always be needed to carry out the calibration operations:
 - a. The CALIBRATION CUP and CALIBRATION CUP SOFT COVER.
 - b. A supply of DEIONIZED WATER.
 - c. A supply of GRANULAR POTASSIUM CHLORIDE REAGENT.

- d. The USE of an ANALYTICAL BALANCE.
- e. A small supply of QUINHYDRONE REAGENT.
- f. BUFFER STANDARDS of pH 4.0, 7.0, 10.0
- g. DISSOLVED OXYGEN SENSOR MEMBRANES
- h. SCISSORS
- i. SOFT PAPER WIPERS (Kleenex)
- j. A 1000-MILLILITER VOLUMETRIC FLASK
- k. A 500-MILLILITER VOLUMETRIC FLASK
- l. A 100-MILLILITER VOLUMETRIC FLASK
- m. A VISE (CLAMP) for holding the Sonde included with Surveyor II.

The mechanical items that you will need continuously during calibrations are the VISE (clamp) and the CALIBRATION CUP and COVER. The vise or clamp stand should be sturdily mounted to the benchtop near your deionized water supply and preferably near a sink.

Precautions:

Safety Considerations:

1. If the sample media is suspected of or known to contain hazardous and/or radiologic contaminants, appropriate personal protective equipment and monitoring will be implemented as outlined in the site specific Health and Safety Plan.
2. After measurements have been carried out, sample water will be disposed of properly.
3. All equipment should be decontaminated after each use.

Transportation Considerations: Initial calibrations are often completed in the laboratory prior to leaving for the field site. In this case, excessive shock or vibration should be avoided as it can cause cumulative damage to sensitive system components, as well as negate calibrations. Cushion the instrument from vibrations.

Special Training Requirements: None

Additional Precautions:

1. Do not let the sensors dry out. This can be avoided by keeping the storage cap, containing a little water, in place on the sonde.
2. Don't allow the instrument to lie in direct sunshine or in such places as the closed trunk of a car, particularly in summer, for long periods because the temperatures inside the sealed Display Unit and Sonde rise to very high levels. This will cause no permanent damage but the operation of the system may be temporarily impaired (stability, calibration). Keeping the instrument in ventilated shade will avoid the heat problem.
3. Very low temperatures should also be avoided. Try to keep the temperatures of the Display Unit and Sonde higher than -10°C. Temperatures below -50°C might cause damage to vulnerable parts such as the liquid crystal display of the Display Unit.

Calibration/Standardization:

It is not necessary to wait until you arrive at the field site to calibrate; however, wherever calibrations are performed, record values in

the field log book. It is much easier to do careful, accurate calibrations under laboratory conditions and the stability of the Surveyor II is such that it will readily maintain calibration during transportation. If you feel better checking calibration in the field, do so of course but treat the findings as an intermediate post-calibration: record the results but do not adjust the system. Adjusting the instrument in the field destroys the value of the reliable laboratory post-calibration and may lead to loss of data quality control.

Note: Do not turn the Surveyor II off between calibration steps or your calibration factors will not be saved. Instructions for saving calibration factors are discussed below.

Frequency: The Surveyor II should be calibrated each time it is taken into the field. It is, however, not necessary to calibrate the Hydrolab between each sample.

Who Performs: Field personnel familiar with the calibration and operation of the Hydrolab.

Criteria for Timing:

Procedures:

Conductivity: The most precise data will be obtained if the Surveyor II conductivity system is calibrated to fit the characteristics of the waters being investigated. That is, if measurements are to be made in fresh water, the low conductivity range of the instrument should be calibrated and the mid and high ranges ignored. Or, if it is seawater that is being surveyed, the high conductivity range should be calibrated and the low and mid ranges ignored. (NOTE: The Surveyor II automatically switches to the range appropriate to the conductive values currently being measured, so you may have the feeling that there is only ONE range. Actually there are three: 0-1.5 mmhos/cm, 1.5-15 mmhos/cm, and 15-150 mmhos/cm with the standard cell; and 0-0.3 mmhos/cm, 0.3-3 mmhos/cm, and 3-30 mmhos/cm

with the D-5 cell attachment in place. If the D-5 cell is required, consult the operating manual.

Standard solutions of potassium chloride salt are used for calibrating the conductive system of the Surveyor II. For maximum accuracy as well as convenience, it is best to make up concentrated stock solutions of the salt (1 molar is suggested) and then to dilute to the concentrations desired. If the stock solution is always made the same, the weighings are always the same with less chance for number errors. And most important, there is no necessity for weighing out tiny amounts of KCl in order to achieve low concentrations. The conductivity ranges of the Surveyor II instrument have been so selected that simply by diluting a 1 molar KCl solution by multiples of 2 and 10, two benchmark solutions can be prepared for each of the low, mid, and high ranges. For example, the low conductivity range can be calibrated at 1.413 millimhos/cm using a 0.01 molar KCl solution. To achieve that concentration, dilute the 1.0 molar stock solution by 10 TWICE. If desired, check the low range at 0.718 millimhos/cm by using the solution resulting after diluting the 1.413 millimhos/cm solution by two.

A slightly different example would be preparing for seawater measurements. Seawater conductivities, of course, run in the low 50's millimhos/cm, so it would be best to calibrate the high range NOT at 111.9 millimhos/cm but at 58.64 millimhos/cm using the 0.5 molar solution obtained by diluting the stock solution by 2. Similarly, if you knew that your measurements would most probably lie in the neighborhood of 0.400 millimhos/cm, the low range would be better calibrated at 0.718 instead of 1.413 millimhos/cm.

In other words, try to calibrate above but as near as possible to the expected data range. However, if your field data should take an unexpected turn and fall into an uncalibrated range, don't worry about it. Go ahead and take your readings, calibrate the range later (post-cal), and correct the readings if required.

LOW RANGE

0	0.718	1.413 mmho/cm
---	-------	---------------

0	0.005M	0.01M conc.
---	--------	-------------

MID RANGE

0	6.668	12.900 mmho/cm
---	-------	----------------

0	0.05M	0.1M conc.
---	-------	------------

HIGH RANGE

0	58.640	111.900 mmho/cm
---	--------	-----------------

0	0.5M	1.0M conc.
---	------	------------

To make the stock solution, weigh out carefully 74.557 grams of reagent grade KCl. Wash the KCl into a 1000 ml volumetric flask and fill to mark with deionized water. Be sure that the KCl dissolves completely before use. The conductivity of the stock solution will be 111.900 millimhos/cm.

TO DILUTE BY 2: Fill the 500 ml volumetric flask to the mark with the solution to be diluted. Transfer the 500 ml into the clean 1000 ml flask. Fill to the mark with deionized water.

TO DILUTE BY 10: Fill the 100 ml flask to the mark with the solution to be diluted. Transfer the contents of the 100 ml flask to the clean 1000 ml flask and fill to the mark with deionized water.

It is safe to keep the stock solution for a few weeks in a tightly sealed, all-glass container, but evaporation and contamination should be kept in mind. If there is any doubt, make a fresh stock solution.

The critical items in the conductivity calibration are TEMPERATURE and KCL CONCENTRATION. Begin as follows:

1. Prepare the standard KCl solution whose conductivity will lie near the top of the range of your measurements.
2. Without removing the calibration cup, rinse the inside of the cup and sensor array several times with deionized water. If your deionized water comes from a tap, remove the sonde from the vise and hold the calibration cup under the tap.
3. Fill the calibration cup about 2/3 with your standard. Cover the cup and shake the Sonde to flush the sensors thoroughly with the standard. Discard the standard in the calibration cup and repeat. Discard the second portion of standard. This procedure is to insure that the concentration of the standard in the cup is what you want it to be.
5. Put the Sonde in the vise, cup up.
6. Fill the cup to within about a centimeter of the top with standard. Be sure that no bubbles are trapped in the bores of the sensor.
7. Switch to TEMPerature. You should find it quite stable by now.
8. Switch to CONDuctivity. Use the SLOPE control to adjust the displayed reading to the value of your standard.
9. The conductivity system is calibrated.

pH calibration: Except in certain special situations, pH buffer solutions are the universal standards for pH calibration. There are buffers available with values over virtually the whole pH range, but the ones used the most have (at 25°C) the pH values 4.0, 7.0, and 10.0. Supplied in powder form, buffers should be prepared with deionized water according to the instructions provided. Buffer solutions will keep for a few weeks at room temperature and so can be made up and stored for calibration purposes.

For best precision, you should calibrate for the range of pH values expected in the field. That is, for high pH waters calibrate at 7.0 and 10.0. For acid water, calibrate at 7.0 and 4.0.

Begin the pH system calibration as follows:

1. With the calibration cup screwed into place, flush the cup and sensors thoroughly with deionized water. Secure the Sonde in the vise, cup up.

2. Fill the cup with pH 7.0 buffer sufficient to cover the membrane of the DO sensor. This is IMPORTANT because the DO sensor plays an indirect but essential part in the pH measurement.
3. Allow a minute or two for thermal equilibration. The importance of thermal equilibrium to measurements can hardly be overstated, not only during calibration but also during measurements in the field.
4. Switch to pH. Now use the ZERO CONTROL to set the displayed value to 7. CAUTION: Be sure to use the ZERO control. The slope control will not have the correct effect.
5. Pour out the 7.0 buffer and flush the sensors with deionized water. CAUTION: It is hard to resist saving the buffer solutions used for calibration and if very careful, they can be retained and used a couple of times without causing errors. But dilution and cross-contamination should be kept in mind as sources of trouble. Whenever in doubt, mix fresh buffers.
6. Fill the cup with pH 4.0 (or pH 10.) buffer (cover the DO sensor) and allow a couple of minutes for equilibration.
7. Use the SLOPE CONTROL to adjust the displayed reading to 4.0 (or 10.0).
8. Remove the 4.0 (or 10.0) buffer, flush the sensors, and check the reading with the 7.0 buffer once more.
9. The reading at 7.0 should have changed little if at all. If it did change slightly, repeat steps (5) through (8).
10. That completes the pH calibration.

Saving Calibration Settings: Now that the Surveyor II has been given all of the calibration information via the ZERO and SLOPE CONTROLS, it is necessary to tell the instrument to store the information in its permanent memory for use during all of the measurements to follow. Again, do not turn the instrument OFF until the calibration factors have been saved. To do this:

FIRST SET THE FUNCTION SWITCH TO 'BATT', THEN
PUSH BOTH CONTROL SWITCHES, SIMULTANEOUSLY, AWAY FROM THE DISPLAY
(TOWARD YOU).
WAIT UNTIL THE WORD 'SAVE' APPEARS IN THE DISPLAY

This SAVING operation MUST be done at the end of the calibration procedure, everytime. If it is not done, the instrument will use

old calibration information from the last SAVE, introducing systematic errors into data that would otherwise be correct.

Calibration of the Surveyor II is finished.

1. Turn the instrument OFF.
2. Remove the calibration cup from the Sonde, half fill the storage cup with deionized water or tap water and screw it onto the Sonde (snugly so that it won't leak).

Installation: None

Operating Procedures:

Moving to the Field: In transporting the Surveyor II, there are three things to be concerned about:

Drying-out of the sensors
Extreme temperatures
Vibration and shock

The first of these won't happen if care is taken to keep the storage cup, containing a little water, in place on the Sonde.

Don't allow the instrument to lie in direct sunshine or in such places as the closed trunk of a car, particularly in summer, for long periods because the temperatures inside the sealed Display Unit and Sonde rise to very high levels. This will cause no permanent damage but the operation of the system may be temporarily impaired (stability, calibration). Keeping the instrument in ventilated shade will avoid the heat problem.

Very low temperatures should also be avoided. Try to keep the temperatures of the Display Unit and sonde higher than -10°C . Temperatures below -50°C might cause damage to vulnerable parts such as the liquid crystal display of the Display Unit.

Excessive shock and vibration can cause cumulative damage to the parts of the system. Never, for instance, carry the instrument loose in the bed of a truck or van. Similarly, nodes of extreme vibration sometimes develop at places in small boats powered by outboard engines. Cushion the instrument from these vibrations.

Field Operations: When you are to the point where you are ready to begin measurements.

1. Remove the storage cup from the Sonde and screw on the circulator in its place.
2. Connect the Circulator to the socket of the data cable.
3. Collect water sample.
4. Place the Sonde in the water, set the Display Unit switch to the desired parameter.

As far as the Surveyor II goes, there is only one item that you have to really concentrate on during field measurements: THERMAL EQUILIBRIUM. With the exception of DEPTH and BATT, all of the measurements are functions of temperature. These functions are stored in the Display Unit, and it is programmed to correct for them before displaying the data. The corrections are based upon the assumption that all of the sensors are at the same temperature as that of the water. If that equilibrium condition is not met, errors will creep into the displayed data values.

Thermal equilibrium is always lost for a brief time whenever the environs of the Sonde change. This will be true when the Sonde is first put into the water and whenever it is moved into cooler or warmer regions of the water column. All that you have to do to avoid errors from this cause is to wait for equilibrium to return before taking your reading. You can judge this by watching the display. In general, the DISSOLVED OXYGEN sensor is the slowest to match its temperature to that of the water, so watch the DO reading. When it has just about stopped changing (changing very slowly) it's time to read all of the parameter values. (If you are not sure that you are allowing enough time for equilibration, take readings at the

same location both as the Sonde is lowered and again as it is recovered. If the descending and ascending readings at corresponding depths differ consistently, you are most likely reading quicker than conditions allow.)

If it becomes necessary to verify calibration in the field, check each parameter by measuring appropriate standards just as you did during the laboratory calibration. But DO NOT USE THE CALIBRATION CONTROLS TO ADJUST THE INSTRUMENT. Just note down the readings vs the standards used. If something has indeed changed, use these readings to make corrections later. But waiting for the results of the post-calibration before disturbing instrument settings avoids confusion and helps with overall data quality control.

It sometimes happens, with conductivity, for example, that values actually encountered in the field unexpectedly fall outside of the range that was calibrated for initially. That is nothing to worry about. Go ahead with the readings and, during post-calibration, use an additional standard to extend the range to include the unexpected readings. Correct the data as required.

When measurements are complete or are to be interrupted for any reason, disconnect and remove the circulator. Screw the storage cup 1/2 filled with clean water onto the Sonde to avoid dryout of the sensors.

Post Calibration:

1. Do post-calibration before doing any sensor maintenance.
2. Follow the same procedure used in the initial calibration preferably using the same equipment and standard solutions, but do not adjust the instrument using the calibration controls.
3. Simply write down the final readings of the standards and make them part of the data documents.

The value of the post-calibration results lies in what they can tell you about what happened to the sensors since the initial calibration. If the post-cal readings duplicate the values of the

standards, you can be confident that the sensors were responding properly to conditions in the water. On the other hand, if one or more of the post-cal readings is out of tolerance, suspect:

1. An error in either the initial or post-calibration. Such things as having forgotten to SAVE the calibration information, using contaminated or deteriorated standards, or failure to allow for thermal equilibration could be the trouble.
2. Sensor fouling. Check the appearance of the sensors for stains or coatings: oils, clays, precipitates, fibrous material, biological material, etc.
3. Instrument malfunction. Check battery voltage. Check for sensor damage. See Malfunctions, Section 4.

Common Problems and Solutions: See Operator's Manual

Special Maintenance:

Servicing the Sensors: In the interests of efficiency, you will want to spend a minimum of time servicing sensors. But at the same time, the hours spent in the field have to produce high quality data. What, then, is the right amount of servicing effort? Try deciding upon the basis of a careful visual examination of the sensors, the results of the post-calibration, and the behavior of the instrument in the field.

If the instrument is responsive and stable in the field, the post-cal measurements are all in tolerance, and visual inspection (made after quick cleanup) reveals no problems, then the quick cleaning described below is all that is required.

On the other hand, irregular behavior in the measurement of any parameter in the field, out-of-tolerance post-cal measurements, or visible trouble signs will help you decide exactly where and what additional work is needed. Information on servicing the instrument can be found in the Operations Manual.

QUICK CLEANUP: Always begin sensor servicing simply by cleaning away silt, oils and greases, and soluble compounds. To do that quickly:

1. Fill the storage cup 1/2 with warm detergent solution and screw it onto the sonde.
2. Shake the sonde vigorously to wash the sensors in the detergent solution.
3. Use a cotton-tipped swab and detergent solution to dislodge remaining foreign matter. Be sure that the threaded area and rubber sealing ring of the sonde endcap are free of grit.
4. Rinse the sensors and sonde endcap with tap or deionized water.
5. Visually check the sensor array for any of the following signs of trouble:
 - (a) Slack, wrinkled, or perforated DO sensor membrane
 - (b) Bubbles in the electrolyte under the DO membrane
 - (c) Obstructions (other than the electrodes) inside the bores of the conductivity cell block
 - (d) Evidence of coatings or precipitates on pH, reference, ORP, or DO sensors, conductivity electrodes
6. If this is to conclude servicing (field performance, post-cal, visual all satisfactory), half fill the storage cup with water and screw it onto the sonde.
7. To do further servicing, see the appropriate sections in the operator's manual.

CAUTION: The glass pH electrode is VERY vulnerable to accidental damage while other sensors or parts of the system are being worked on. Make it a habit always to protect the electrode by slipping a piece of flexible, thick-walled tubing (Tygon) over it during servicing operations.

Data Recorded in the Field: Field data recorded as part of this procedure includes:

Calibration information for temperature, pH, and conductivity (if done in field), including manufacturer and lot number of all calibration standards.

Date and time of calibration

Date and time of field measurements

Values measured for pH, temperature, and conductivity

Post calibration readings

Sampling site identification and pertinent sampling information
(i.e. volume of purge water for which sample was collected,
etc.).

Data Reduction: None if field measurements fall within calibration
limits. If field values are outside calibration limits, connections
to the data are made after post calibration procedures are
completed.

Data Reporting:

<u>Units:</u>	pH:	standard units
	Temperature:	degrees C
	Conductivity:	mmhos/cm
	Dissolved oxygen:	mg/l

Precision: see operators manual

Accuracy: see operators manual

Comments: see operators manual

General QA/QC comments: None

FIELD SAMPLING METHOD (FSM #8)

DECONTAMINATION

This procedure describes equipment decontamination procedures to prevent cross contamination. Additional information concerning personnel decontamination and site-specific decontamination plans is provided in the health and safety plan. All reusable equipment will be decontaminated before re-use. Disposable equipment (where applicable, available, and acceptable from a laboratory analysis standpoint) will save both time and money and ensure no cross contamination occurs.

Heavy Equipment:

Drill rigs, drilling tools, and other heavy equipment are difficult to decontaminate. The methods generally used are steam cleaning or washing heavy equipment with water under high pressure, or scrubbing accessible parts with a detergent and water solution under pressure. Particular care must be given to those components potentially coming into direct contact with contaminants.

The following procedure is recommended:

1. Physically remove any bulk material adhering to the item that requires decontamination by using wire brushes or scrapers. If necessary, use water and a nonphosphate detergent to assist in dislodging and removing contaminated material.
2. Steam clean the item.
3. Use an appropriate solvent rinse if persistent contamination is detected (radioactive) or suspected (chemical). Pesticide-grade methanol is the solvent of choice; however, less expensive solvents such as Hexane can be used. The analytical laboratory must be informed of the type of decontamination solvent used.
4. Collect a swipe sample for immediate radioactive analysis if the item is known to be or suspected of being radioactively contaminated (see Steps 6-8).
5. Rinse the decontaminated item with ASTM Type II water. Collect one equipment (rinsate) blank for parameters of interest using analyte free water.
6. Obtain a swipe (10 cm x 10 cm) from the equipment for a radiation contamination check.

7. The item is considered clean and suitable for use if there are <50 dpm/100 cm² (beta, gamma).
8. Repeat Steps 4, 5, and 6 if the results are greater than the above limits. If the limits are still not met, consider using appropriate decontamination solutions or disposing of and replacing the item.

Drilling Equipment:

The drill rig and its tools must be decontaminated to prevent cross contamination. Decontaminate the drill rig and tools prior to the start of drilling operations and between bore holes to prevent contamination from one bore hole to another. Whenever drilling operations are suspended (such as on a daily basis) and the tools are removed from the bore hole or well, the tools must either be decontaminated prior to reinsertion into the bore hole or well, or suitably protected from accidental contamination by dust and other matter which originates from the land surface near the well head (sealed bags). Periodically decontaminate the tools to minimize the probability of cross contamination within a bore hole or well.

Well Completion Materials:

Well completion materials, such as removable casing, screen, casing, sand for the filter pack, bentonite, cement, and concrete, must also be free of contaminants. Both materials and services should be specified contaminant-free when purchasing or contracting for them. Prior to inserting temporary casing into the bore hole, it will be steam cleaned. Screen and well casings shall be obtained from the manufacturer in a cleaned condition whenever possible (casings will be decontaminated if the manufacturer supplies dirty casings). These materials must be sealed in plastic to prevent contamination both during transportation and when in storage on-site prior to use. Casing joint lubricant(s) will be limited to material such as molybdenum-based lubricants, which do not contain the monitored contaminants.

Decontamination of Sampling Equipment:

The following section describes the decontamination procedures to be followed when cleaning sampling equipment. As discussed above, rinsate samples of a

final water rinse (Analyte free) will be collected for analysis to provide quality assurance (QA) in the decontamination method. Where appropriate, and whenever possible, disposable equipment and containers will be used to minimize field decontamination requirements, thus saving time and money, reducing the potential for cross contamination, and minimizing the generation of waste solvents which require disposal. If an item cannot be satisfactorily decontaminated in the field, that item will be shipped to the laboratory for appropriate decontamination.

The full decontamination procedure for sampling equipment used for both organic and metal sampling is as follows:

1. Remove gross contamination with tap water, rinse using pressurized or gravity flow tap water. Scrub brushes or wire brushes may help in removal.
2. Wash and scrub thoroughly with a non-phosphate detergent and tap water.
3. Rinse thoroughly with tap water.
4. Check for adhered soils; use a brush to dislodge any particles.
5. Rinse with deionized water.
6. If a rinsate sample is required for QA, make an additional final rinse of the item, using analyte free water, and collect it for analysis. Allow cleaned equipment to air dry indoors, or if possible, within an area protected from wind-blown dust. A methanol solvent rinse is optional for ground-water sampling (U.S. EPA, 1985).

Note: Methanol is recommended as a solvent rinse because its ion fragments are not detectable in a gas chromatography/mass spectrometry (GC/MS) analysis. With acetone and other common solvents, ion fragments are always detectable in a GC/MS analysis. An item can be steam cleaned between Steps 4 and 5 if a steam cleaner is available and the equipment material is not heat and steam sensitive.

Water used for decontamination will be contained and treated at the TAN Portable Water Treatment Unit prior to disposal. Solids will be containerized with sampling, analysis, and disposal dependent on the status of the well cuttings at each specific well site. Health and safety of the decon work will be as discussed in the Health and Safety Plan, and as directed by the project IH and HP. All solvents used for decontamination shall always be collected for proper disposal.

FIELD SAMPLING METHOD (FSM #9)

NATURAL GAMMA-RAY WELL LOGGING

Gamma-Ray logging at the INEL will be performed by the USGS. Their standard practices and procedures will be implemented. USGS personnel will follow the health and safety practices being implemented for the RI/FS (see attached Health and Safety Plan addendum). Copies of the geophysical logs will be made a part of the End of Well (EOW) reports and will be incorporated into the RI report as an appendix. Originals of the geophysical logs are maintained by the USGS.

FIELD SAMPLING METHOD (FSM #10)

GAMMA-GAMMA WELL LOGGING

Gamma-Gamma logging at the INEL will be performed by the USGS. Their standard practices and procedures will be implemented. USGS personnel will follow the health and safety practices being implemented for the RI/FS (see attached Health and Safety Plan addendum). Copies of the geophysical logs will be made a part of the End of Well (EOW) reports and will be incorporated into the RI report as an appendix. Originals of the geophysical logs are maintained by the USGS.

FIELD SAMPLING METHOD (FSM #11)

CALIPER WELL LOGGING

Caliper logging at the INEL will be performed by the USGS. Their standard practices and procedures will be implemented. USGS personnel will follow the health and safety practices being implemented for the RI/FS (see attached Health and Safety Plan addendum). Copies of the geophysical logs will be made a part of the End of Well (EOW) reports and will be incorporated into the RI report as an appendix. Originals of the geophysical logs are maintained by the USGS.

FIELD SAMPLING METHOD (FSM #12)

NEUTRON WELL LOGGING

Neutron logging at the INEL will be performed by the USGS. Their standard practices and procedures will be implemented. USGS personnel will follow the health and safety practices being implemented for the RI/FS (see attached Health and Safety Plan addendum). Copies of the geophysical logs will be made a part of the End of Well (EOW) reports and will be incorporated into the RI report as an appendix. Originals of the geophysical logs are maintained by the USGS.

FIELD SAMPLE METHOD (FSM #13)

PACKER PUMPING TEST

This test is performed on open holes. In addition to the Theis assumptions this test assumes that there is no communication around the packer within the bore hole. This assumption will be tested by monitoring water levels above the packer and within the interval being tested with transducers.

Transducer Check (should be conducted before the start of the test):

1. Check calibration status of the transducer.
2. Lower the transducer to a depth a few feet below the water table and mark the location on the transducer lead.
3. Record reading from the data logger.
4. Measure several feet from the first mark and mark the second depth.
5. Lower the transducer to the second mark.
6. Record the second reading and subtract from the first (see attached data sheet).
7. If readings vary more than 1% from the measured value, recheck measurement between tape marks and repeat.
8. If the second trial fails, then either the transducer is defective or the density of the water is non-standard. Resolve this question before proceeding.

Field Procedures:

1. Fill out the data sheet as appropriate.
2. Evaluate recovered core/well log/geological logs as available for the locations and depth of potentially enlarged sections in the well bore. Determine the optimum packer placement based on the available data.
3. Orient the fixed head of the packer toward the submersible pump.
4. Check that all connections are tight and that wiring harness through the packer is free and in good condition.

5. Connect inflation tubing making sure that the lines are not kinked and do not have open loops of excess line that can become tangled in the open hole.
6. Connect lifting eye and one section of piezometer riser pipe and up-hole inflation line.
7. Connect electrical pump wire leads.
8. Attach safety/hoisting cable to lifting eye.
9. Attach the pressure transducer to the access tube for the zone below the packer. Install the transducer with the highest rating in the lower zone. Note the transducer serial numbers on the data sheet so there is no question as to which transducer is monitoring which zone.
10. Begin lowering system down the bore hole using teflon tape at connections and taping inflation lines, electrical wires, and transducer cables to every section of pipe. Loosely tape first 50 ft or so to the piezometer allowing enough slack to travel as the packer inflates.
11. Add support pipe sections as assembly is lowered to the test zone. KEEP TRACK OF THE NUMBER OF PIPE SECTIONS ADDED!
12. Attach the upper transducer to riser at a depth to be in the water but above the maximum rating of the transducer ($2.31 \times \text{transducer psi rating} = \text{maximum feet of water}$)
13. Connect 3-way valve and regulator to nitrogen cylinder when the test zone is reached.
14. Inflate packer adequately to insure seal over ambient water head. To calculate the inflation pressure use the pressure curve supplied by the packer manufacturer and follow this example. If the packer is to be set at 300 ft and the depth to water is 200 ft the packer would have 100 ft of water pressure on it. By dividing the depth of the water column by 2.31 the pounds per square inch equivalent can be calculated. In this case it would be 43.3 psi on the packers. Thus 43.3 psi would be required to overcome the water pressure alone, and this should be added to the pressure necessary to inflate the packer to the desired diameter.
15. Measure axial and annular static water levels.
16. Connect the transducer leads to the data logger and check readings. Set the data logger to record data on a logarithmic time interval.
17. Connect surface assembly to riser pipe.
18. Connect flow meter assembly to riser pipe.

NOTE: Purge the isolated zone and collect groundwater samples per FSM #14. Allow the zone to stabilize prior to starting pumping test.

19. Start the data logger and pump simultaneously. Help may be necessary to accomplish this.
20. Water will not come out the riser pipe for several seconds as the pipe fills with water. If the zone is tight the pump will run out of water and burn the bearings. Frequently check to see if air is being evacuated from the riser pipe indicating that the water level is rising and the pump is pumping water. If no air is being evacuated from the pipe, stop the pump immediately and let the zone recover.
21. Monitor discharge with the flowmeter and check by measuring the amount of time it takes to fill a 5 gallon bucket.
22. Assuming that the zone can produce enough water for the test, monitor the drawdown until conditions stabilize or for 12 hours whichever comes first.
23. If the zone cannot produce adequate water, reduce the discharge rate using the valve on the surface assembly to a rate where the pump does not evacuate the zone. Resume the test until drawdown stabilizes or for 12 hours.
24. For normal terminations step the data logger and restart it as the pump is shut off to record the recovery data.
25. Record the recovery data for 12 hours or until the recovery data stabilizes whichever comes first.
26. Deflate the packers, extract the system from the well, and decontaminate prior to reuse (see FSM #8).

AQUIFER TEST FIELD DATA SHEET

Date: _____

Pumped Well: _____

Location: _____

Observation Well: _____

Observers: _____

Transducer Check

	First Trial	Second Trial
Second Reading (___ ft deeper)	_____	_____
First Reading	_____	_____
Difference	_____	_____

(Transducer should be accurate within 1% of measured value)

Measuring point is _____ which is _____ feet above/below land surface.

Static water level _____ (feet below measuring point).

Distance to pumped well _____ feet.

Discharge rate of pumped well _____ gpm (gallons per minute).

Total number of observation wells _____.

Weather conditions: _____

Barometric pressure: beginning of test _____

end of test _____ Depth of well _____

Open interval _____

Transducers: _____

Depth (below measuring point) of top of packer: _____

Depth (below measuring point) of bottom of well: _____

Isolated interval (below measuring point): _____.

Hydrogeologist _____ Checked by _____

Field Notes: _____

FIELD SAMPLING METHOD (FSM #14)

GROUNDWATER SAMPLING USING A PACKER-PUMP ASSEMBLY

This procedure is carried out in conjunction with FSM #13 "Packer pumping tests." Prior to performing the packer pumping test, purge 3 well casing volumes from the isolated zone. Monitor groundwater discharge during purging for pH, temperature, specific conductance and total dissolved solids (TDSs), and (optional) dissolved oxygen (see FSM #7). Once the parameters have stabilized as given in FSM #4, groundwater samples can be collected.

Field Procedure:

1. Install packer-pump assembly.
2. Monitor discharge for pH, temperature, specific conductance and TDSs, and (optional) dissolved oxygen. Once parameters stabilize and 3 casing volumes have been evacuated from the isolated zone, sampling can be carried out.
3. Turn down discharge to 0.1 gpm or as low as reasonably achievable.
4. Fill and cap sample containers (VOA vials) ensuring no headspace.
Note: For these samples, triplicate samples will be collected.
5. Allow zone to stabilize and perform aquifer test (FSM #13).

FIELD SAMPLING METHOD (FSM #15)

FIELD SCREENING OF DRILL CUTTINGS FOR VOCs AND RADIONUCLIDES

Samples of drill cuttings from below the water table will be collected from each drill site and will be field screened to determine final disposition. Samples will be screened for VOCs (using the headspace method), for beta/gamma-emitting radionuclides (using a Ludlum 2A or equivalent instrument), and for alpha-emitting radiological activity (using a Ludlum 61 or equivalent instrument) according to the following procedures:

Volatile Organic Compounds

1. Obtain a cuttings sample aliquot from the cuttings container with a stainless steel spoon or spatula, disturbing the sample as little as possible.
2. Place the sample in a 250-ml wide-mouth glass container, leaving a headspace of approximately one inch.
3. Cap the container with a piece of aluminum foil and secure it with a rubber band.
4. Place the container in a 70°F water bath for 20 minutes.
5. After the sample has been warmed and has released any potential VOCs into the headspace, puncture the aluminum foil with an HNu instrument probe and take immediate measurements of VOCs.

Note: Water vapor may affect HNu instrument readings.

6. Record results on the attached worksheet.
7. If VOCs are detected at levels exceeding 25 ppm for any of the samples, collect and analyze a confirmation sample. If the confirmation sample also exceeds 25 ppm, cuttings from that site will be kept containerized, and a sample will be collected and submitted for TCLP (toxic characteristic leach procedure) analysis.

Beta/Gamma- and Alpha-Emitting Radionuclides

1. Obtain a composite cuttings sample from the cuttings container with a stainless steel spoon or spatula.
2. Place the sample in a clean stainless steel or aluminum pan.
3. Survey the sample for beta/gamma-emitting radionuclides (using a Ludlum 2A) and for alpha-emitting radionuclides (using a Ludlum 61).
4. Record the results on the attached worksheet.
5. If beta/gamma radiation exceeds 100 counts per minute or if any alpha radiation is detected, collect and analyze a confirmation sample. If the confirmation sample also exceeds the above limits, collect and submit samples for beta/gamma and/or alpha isotopic analyses.

Worksheet for Analysis of Drill Cuttings

Sampled by: _____ Date: _____

Well Number: _____ Container Number: _____

Sample Description: _____

HNu Reading:

First Sample: _____

Confirmation Sample: _____

Ludlum 2A Reading (beta/gamma):

First Sample: _____

Confirmation Sample: _____

Ludlum 61 Reading (alpha):

First Sample: _____

Confirmation Sample: _____

APPENDIX C

FIELD LOGBOOKS

FIELD LOGBOOKS

1. Sample and Core Description Logbook
2. Well Drilling, Installation, and Development Logbook
3. Field Team Leader's Daily Logbook
4. Field Instrument Calibration/Standardization Logbook
5. Sample Logbook
6. Sample Shipping Logbook

INEL RCRA/CERCLA INVESTIGATIONS

**SAMPLE AND CORE DESCRIPTION
LOGBOOK - I**

WELL NO: _____

DATE START _____, 19 _____

DATE END _____, 19 _____

LOGBOOK NO: _____

LOGBOOK ASSIGNED TO: _____

SITE: _____

WHEN COMPLETED RETURN TO: DONNA KIRCHNER
MS: 3900

INSTRUCTIONS FOR USE OF THIS NOTEBOOK

1. Use indelible BLACK ink for all entries.
2. DO NOT ERASE - line out mistakes using one line only, enter correct information above or beside the mistake. Initial and date the correction.
3. DO NOT use white-out.
4. INITIAL all entries where space is provided.
5. After all entries on a page have been completed, VERIFY using complete signature at the bottom of the page.

Borehole: _____

Sample No.: _____

Cored Interval: _____ Top
 _____ Bottom

[illegible]

Remarks: _____

INEL RCRA/CERCLA INVESTIGATIONS

**WELL DRILLING, INSTALLATION
AND DEVELOPMENT LOGBOOK**

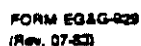
DATE START _____, 19 _____

DATE END _____, 19 _____

LOGBOOK NO: _____

LOGBOOK ASSIGNED TO: _____

SITE: _____

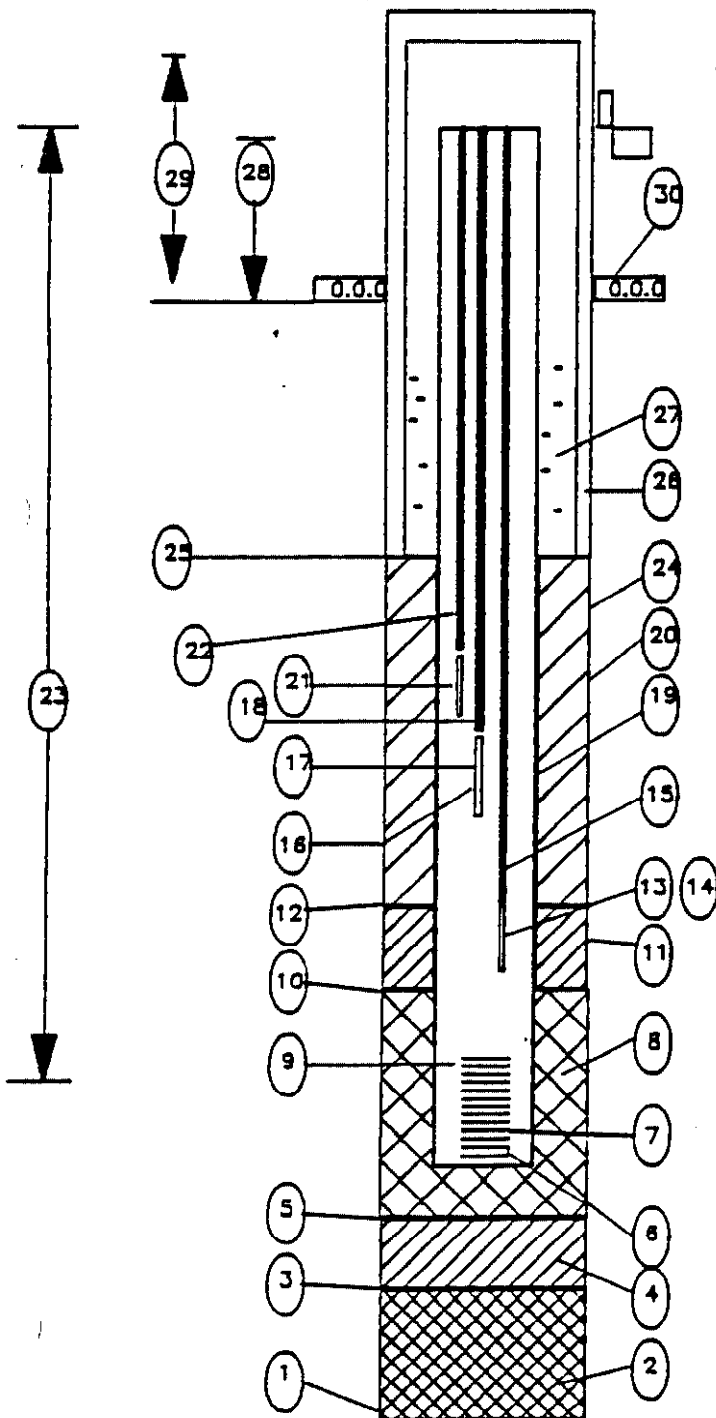


FIELD LOG OF DRILL HOLE

Datum

C-8

EG&G IDAHO INC.	MONITORING WELL INSTALLATION LOG	BOREHOLE/WELL NUMBER: _____
PROJECT NUMBER _____		GROUND SURFACE ELEVATION _____
PROJECT NAME _____		TOP OF WELL CASING ELEVATION _____
INSTALLATION TEAM _____		START DATE _____ TIME _____
FIELD GEOLOGIST _____		END DATE _____ TIME _____



1. ELEV/DEPTH OF BOREHOLE _____ FEET
2. TYPE OF LOWER BACKFILL (IF INSTALLED) _____
3. ELEV/DEPTH OF BOTTOM OF BOTTOM SEAL (IF INSTALLED) _____ FEET
4. TYPE OF BOTTOM SEAL _____
5. ELEV/DEPTH TO TOP OF BOTTOM SEAL _____ FEET
6. ELEV/BOTTOM DEPTH OF WELL SCREEN _____ FEET
7. TYPE OF SCREEN MATERIAL _____
DIAMETER OF SCREEN _____ SLOT SIZE OF SCREEN _____
8. TYPE OF FILTER PACK AROUND SCREEN _____
9. ELEV/DEPTH TO TOP OF WELL SCREEN _____ FEET
10. ELEV/DEPTH TO BOTTOM OF TOP SEAL _____ FEET
11. TYPE OF UPPER SEAL _____
12. ELEV/DEPTH TO TOP OF TOP SEAL _____ FEET
13. ELEV/DEPTH OF BOTTOM OF SAMPLING PUMP (IF INSTALLED) _____ FEET
14. TYPE OF SAMPLING PUMP _____
15. TYPE OF SAMPLING PUMP DISCHARGE LINE _____
16. ELEV/DEPTH OF SUBMERSIBLE PUMP (IF INSTALLED) _____ FEET
17. TYPE OF SUBMERSIBLE PUMP _____
18. TYPE OF SUBMERSIBLE PUMP DISCHARGE LINE _____
19. TYPE OF WELL CASING _____
DIAMETER OF WELL CASING _____
20. TYPE OF UPPER BACKFILL/GROUT _____
21. ELEV/DEPTH OF WATER-LEVEL ACCESS TUBE _____ FEET
22. TYPE OF WATER-LEVEL ACCESS LINE _____
23. TOTAL LENGTH OF WELL CASING _____ FEET
24. BOREHOLE DIAMETER _____ FEET
25. ELEV/DEPTH TO BOTTOM OF SURFACE/PROTECTIVE CASING _____ FEET
26. TYPE OF SURFACE/PROTECTIVE CASING _____
DIAMETER OF PROTECTIVE CASING _____ FEET
27. TYPE OF UPPER SEAL (IF INSTALLED) _____
DEPTH TO BOTTOM OF UPPER SEAL _____ FEET
28. ELEV/HEIGHT OF WELL CASING ABOVE GROUND _____ FEET
29. PROTECTIVE CASING? YES NO
ELEV/HEIGHT ABOVE GROUND _____ FEET
LOCKING CAP? YES NO
30. CONCRETE CAP YES NO

EG&G IDAHO INC.

WELL DEVELOPMENT DATA

BOREHOLE/WELL NUMBER:

PROJECT NUMBER _____

START DATE _____

TIME _____

PROJECT NAME _____

END DATE _____

TIME _____

DEVELOPMENT TEAM _____

TOTAL WELL DEPTH (BTC) _____

WELL INSTALLATION COMPLETION DATE _____

WELL DIAMETER _____

NOTE: 1 GAL = 0.1337 FT³

WELL VOLUME/FOOT _____

Time	pH	Temp.	Specific Conduct.	Dissolved Oxygen	Total Dissolv. Solids					

♦ BTC = BELOW TOP OF CASING

DATA VERIFIED BY _____ DATE _____

DATA REVIEWED BY _____ DATE _____

WELL DRILLING & INSTALLATION NOTES

INEL RCRA/CERCLA INVESTIGATIONS

FIELD TEAM LEADER'S DAILY LOGBOOK

DATE START _____, 19 _____

DATE END _____, 19 _____

LOGBOOK NO: _____

LOGBOOK ASSIGNED TO: _____

SITE: _____

WHEN COMPLETED RETURN TO: D. KIRCHNER
MS: 3900

INSTRUCTIONS FOR COMPLETING FIELD TEAM LEADERS DAILY LOGBOOK

In some very large sampling activities e.g. where there is a drilling crew, a sample collection crew, a shipping crew etc. and a field team leader that oversees all of the activities it may be necessary to record information on the daily activities of each of these crews. The size of the site and the preference of the field team leader will dictate whether or not this logbook is needed. This logbook should not be confused with the Sample Logbook. The purpose of the Sample Logbook is to record activities and conditions surrounding collection of a physical sample. This logbook is restricted to activities of a "sampling crew". The purpose of the Field Team Leader's Daily Logbook is to record information on field activities when several different crews are involved.

On the first page of the logbook record the name and signature of all field team members. You may wish to restrict this list to field workers whose name may appear on any field documentation e.g. field tags, labels, etc. The purpose is to be able to compare the handwriting on a field document to the signature in this logbook in the event a question should arise on the authenticity or reliability of an entry.

Should any visitors e.g. representatives from the State of Idaho or EPA or any auditors visit a site during field activities their name and purpose of visit should be recorded.

FIELD TEAM LEADER'S DAILY LOGBOOK

SAMPLING TEAM

NAME (Print)

SIGNATURE

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Visitors Name

Reason for Visit

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

FIELD TEAM LEADER'S DAILY LOGBOOK

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

INEL RCRA/CERCLA INVESTIGATIONS

**FIELD INSTRUMENT CALIBRATION/
STANDARDIZATION LOGBOOK**

DATE START _____, 19 _____

DATE END _____, 19 _____

LOGBOOK NO: _____

LOGBOOK ASSIGNED TO: _____

WHEN COMPLETED RETURN TO: D. KIRCHNER
MS: 3900

Instructions for Completing Field Instrument Calibration/ Standardization Logbook

One logbook should be maintained for each piece of equipment. The logbook should be kept with the equipment at all times and periodically checked by equipment operators and field team leaders.

The logbook should contain a continuous log of the users of the instrument and any calibrations that were performed. List the date and time of calibration as well as the use of any calibration standards.

Instrument Property or Serial Number: _____

[illegible]

INEL RCRA/CERCLA INVESTIGATIONS

SAMPLE LOGBOOK

DATE START _____, 19 _____

DATE END _____, 19 _____

LOGBOOK NO: _____

LOGBOOK ASSIGNED TO: _____

SITE: _____

WHEN COMPLETED RETURN TO: D. KIRCHNER
MS: 3900

DIRECTIONS FOR COMPLETING SAMPLE LOGBOOK

Table of Contents: The TOC will be entered into a computer database to quickly retrieve and locate information from all sample logbooks. Therefore, the TOC must be complete.

Sampling Date: Enter the date the samples were collected.

Location: Enter the location (and when appropriate the ID number) of sample collection.

Description of Sample: Enter the media of the sample e.g. groundwater, soil

Page Number of Sample Logsheet: Enter the first page number of the Sample Logsheet

Narrative Sheet: The narrative section contains a description of the days activities of the sampling crew.

Team Members: Print the names of all sampling crew members.

Weather: Enter a description of weather conditions at the start of sampling. If conditions change before sampling is complete then record the change under Narrative.

Narrative: Enter times and locations of the sampling crew. Enter a description of the sampling points identified on the map page of the logbook.

Map of Sampling Locations: Complete the orientation arrow on the top of the page. Draw a picture of sample collection points. Include the location of reference points.

Sample Logsheet: This logsheet was prepared for a sampling activity that collects samples from one media e.g. pond or soil at several locations using one sampling method. The two pages of the sample logsheet will be entered into a computer database to perform a completeness check on the number and kinds of samples collected compared to the number and kinds stated in a sampling and analysis plan. It is important that these logsheets be completed fully. If a section does not apply to a particular activity then draw a single line and write NA through the section.

SAMPLE LOGBOOK

Date (mm/dd/yy): _ _ / _ _ / _ _

Field Team Members:

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Weather: _____

Narrative (description of field sampling activities with time and location, description of sampling point, and samples collected.):

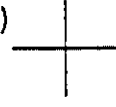
RECORDED BY: _____ (Signature) QA CHECK BY: _____ (Signature)

SAMPLE LOGBOOK

RECORDED BY: _____ QA CHECK BY: _____

SAMPLE LOGBOOK

MAP OF SAMPLING LOCATION:
(include location of sampling points and reference points)



RECORDED BY: _____ QA CHECK BY: _____

SAMPLE LOGBOOK

DATE(MM/DD/YY): ____/____/____ LOCATION: _____

SAMPLE TYPE: (0) Normal (1) Equip. Blank (PRIOR) (2) Trip Blank (3) Replicate (4) Split
(5) Equip. Blank (POST) (6) Spike (7) Other _____

ID NO.	CODE	POINT (LOCATION)	DEPTH		(UNITS) BELOW SURFACE
			FROM	TO	
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

SAMPLE METHOD: CODE: (____)
(0) Grab (1) Spatial Comp. (2) Time Comp. (3) Other _____

SAMPLE DESCRIPTION: CODE (____)

<u>SOIL/ROCK</u>	<u>SEDIMENT/SLUDGE</u>	<u>LIQUIDS</u>
(00) Surf. Soil	(05) Pond/Impoundment	(08) Pond/Impoundment
(01) Sub. Surf. Soil	(06) Drum/Tank	(09) Drum/Tank
(02) Basalt	(07) Other	(10) Plant Discharge
(03) Sediment Interbed	<u>AIR/GAS</u>	(11) Spring/Seep
(04) Other	(15) Soil Gas	(12) Perched Aquifer
	(16) Other	(13) Regional Aquifer
Other: _____		(14) Other

FIELD MEASUREMENTS: (list field measurements of the samples)

ID No.	Measurement	Units	Instr. Make/Model	Instr. No.
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

SAMPLING AND ANALYSIS PLAN FOLLOWED: NO (____) YES (____) IF NO EXPLAIN DEVIATIONS:

RECORDED BY: _____ QA CHECK BY: _____

[\[1\]](#) [\[2\]](#) [\[3\]](#) [\[4\]](#) [\[5\]](#) [\[6\]](#) [\[7\]](#) [\[8\]](#) [\[9\]](#) [\[10\]](#) [\[11\]](#) [\[12\]](#) [\[13\]](#) [\[14\]](#) [\[15\]](#) [\[16\]](#) [\[17\]](#) [\[18\]](#) [\[19\]](#) [\[20\]](#) [\[21\]](#) [\[22\]](#) [\[23\]](#) [\[24\]](#) [\[25\]](#) [\[26\]](#) [\[27\]](#) [\[28\]](#) [\[29\]](#) [\[30\]](#) [\[31\]](#) [\[32\]](#) [\[33\]](#) [\[34\]](#) [\[35\]](#) [\[36\]](#) [\[37\]](#) [\[38\]](#) [\[39\]](#) [\[40\]](#) [\[41\]](#) [\[42\]](#) [\[43\]](#) [\[44\]](#) [\[45\]](#) [\[46\]](#) [\[47\]](#) [\[48\]](#) [\[49\]](#) [\[50\]](#) [\[51\]](#) [\[52\]](#) [\[53\]](#) [\[54\]](#) [\[55\]](#) [\[56\]](#) [\[57\]](#) [\[58\]](#) [\[59\]](#) [\[60\]](#) [\[61\]](#) [\[62\]](#) [\[63\]](#) [\[64\]](#) [\[65\]](#) [\[66\]](#) [\[67\]](#) [\[68\]](#) [\[69\]](#) [\[70\]](#) [\[71\]](#) [\[72\]](#) [\[73\]](#) [\[74\]](#) [\[75\]](#) [\[76\]](#) [\[77\]](#) [\[78\]](#) [\[79\]](#) [\[80\]](#) [\[81\]](#) [\[82\]](#) [\[83\]](#) [\[84\]](#) [\[85\]](#) [\[86\]](#) [\[87\]](#) [\[88\]](#) [\[89\]](#) [\[90\]](#) [\[91\]](#) [\[92\]](#) [\[93\]](#) [\[94\]](#) [\[95\]](#) [\[96\]](#) [\[97\]](#) [\[98\]](#) [\[99\]](#) [\[100\]](#)

RECORDED BY: _____ QA CHECK BY: _____

INEL RCRA/CERCLA INVESTIGATIONS

SAMPLE SHIPPING LOGBOOK

DATE START _____, 19 _____

DATE END _____, 19 _____

LOGBOOK NO: _____

LOGBOOK ASSIGNED TO: _____

WHEN COMPLETED RETURN TO: D. KIRCHNER
MS: 3900

DIRECTIONS FOR COMPLETING SAMPLE SHIPPING LOGBOOK

One line must be completed for each sample. Note that drilling cores are considered samples.

SAMPLE IDENTIFICATION NUMBER: Enter the sample identification number.

DATE COLLECTED: Enter the date the sample was collected. This should correspond with the date entered on the sample label, tag, and in the Sample Logbook.

LAB OR STORAGE AREA: Enter the name of the analytical laboratory or core storage area that the sample was shipped to.

DATA SHIPPED: Enter the date the sample was shipped to the analytical laboratory. Note: This includes both on-site (within INEL) and off-site laboratories.

C-27 Every cooler or container must be identified with a unique number. Enter number of the cooler in parenthesis after the date shipped.

CHAIN-OF-CUSTODY-NUMBER: Chain-of-custody form(s) must accompany each sample. Every COC form must have a serialized number. Enter the unique serialized number of the COC form.

SAMPLE SHIPPING CLASSIFICATION: Enter the DOT or EPA classification of the sample.

SHIPPED BY: The qualified shipper responsible for the classification, packaging, and shipping of the sample should sign the sheet.

QA CHECK BY: A second person who can attest to the correctness of the information should sign the sheet.

[illegible]

SHIPPED BY: _____ (Signature) QA CHECK BY: _____ (Signature)